

TASCAM
TEAC Production Products



SERVICE MANUAL

122

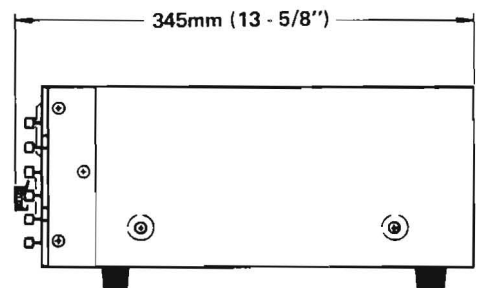
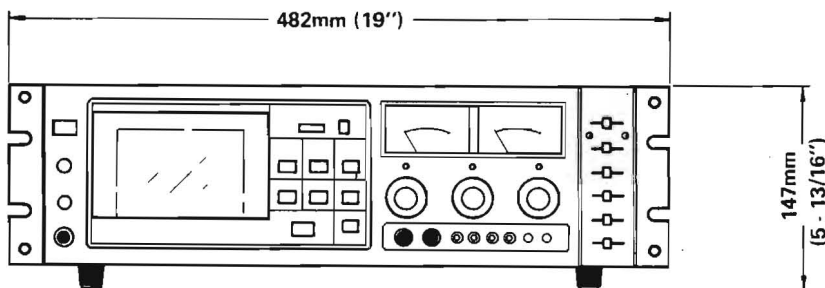
MASTER CASSETTE DECK

TABLE OF CONTENTS

1. Specifications	3	6-4. Capstan assembly thrust	44
2. Features and controls		6-5. Takeup torque	44
2-1. Front panel features and controls ..	4	6-6. Fast forward and rewind torque ...	44
2-2. Rear panel connections	5	6-7. Pinch roller pressure	44
3. Circuit description		6-8. Tape speed	45
Control section		6-9. Wow and flutter	45
3-1. System control IC	6	7. Record/reproduce amplifier checks and adjustments	
3-2. System control IC input/output circuits	9	7-1. Reproduce output level setting	47
3-3. Solenoid drive circuit	10	7-2. VU meter setting	47
3-4. Reel motor drive circuit	15	7-3. Reproduce frequency response	47
3-5. Capstan motor circuit	18	7-4. Bias setting adjustment	48
3-6. Tape-end detection circuit	18	7-5. Record level	48
3-7. Memory circuit	20	7-6. Overall frequency response	48
3-8. Power supply circuits	20	7-7. Overall signal-to-noise ratio	49
3-9. Overall operation of the deck	24	7-8. Overall distortion	49
3-10. Muting circuits	26	7-9. Erasure	49
Amplifier section		7-10. Channel separation	50
3-11. Reproduce circuit	30	7-11. LED lighting of VU meter (PEAK indicator)	50
3-12. Monitor circuit	32	7-12. Dolby Noise Reduction effect	50
3-13. Record circuits	34	7-13. Dolby HX effect	50
3-14. Dolby HX circuit	37	7-14. Headphones output level	51
4. Parts location	41	7-15. Bias trap adjustment	51
5. Essential maintenance equipment/material	42	7-16. BIAS/REC calibration check	51
6. Electro-mechanical checks and adjustments		8. Exploded views and parts lists	52
6-1. Head base plate positioning	43	9. PC boards and parts lists	58
6-2. Microswitch (A) assembly clearance	43	10. Semiconductors lists	67
6-3. Microswitch (B) assembly clearance	43	11. Assembling hardware coding lists	68
		12. Block-diagram	69

- NOTES: 1. In the diagram of each PC board, its pattern surface is shown.
 2. With certain exceptions, the reference numbers in the 100's, 300's and 700's refer to the Lch, and those in the 200's, 400's and 800's to the Rch.
 3. Parts marked with \triangle are safety critical components.
 They must always be replaced with components specified by TEAC.
 4. Service data are found where they are necessary.
 Improvements may result in service data changes without notice.

- Dolby Noise Reduction System manufactured under license from Dolby Laboratories Licensing Corporation.
- 'Dolby' and the double-D symbol are trademarks of Dolby Laboratories Licensing Corporation.



1. SPECIFICATIONS

MECHANICAL

Tape:	Philips Type Cassette C-60 and C-90
Track Format:	4-Track, 2-Channel Stereo
Tape Speed:	1-7/8 ips and 3-3/4 ips
Speed Accuracy:	1-7/8 ips $\pm 0.5\%$ Deviation
	3-3/4 ips $\pm 0.5\%$ Deviation
Wow & Flutter:	1-7/8 ips ¹⁾ $\pm 0.085\%$ peak (DIN/IEC/ANSI weighted)
	$\pm 0.18\%$ peak (DIN/IEC/ANSI unweighted)
	0.06% (NAB weighted)
	0.11% (NAB unweighted)
	3-3/4 ips ²⁾ $\pm 0.055\%$ peak (DIN/IEC/ANSI weighted)
	$\pm 0.13\%$ peak (DIN/IEC/ANSI unweighted)
	0.04% (NAB weighted)
	0.07% (NAB unweighted)
Fast Wind Time:	90 secs. for MTT-501 (C-60)
Motor:	1 FG Servo Controlled DC Motor
	1 DC Reel Motor
Head Configuration:	3 Heads; Erase, Playback/Record
Dimensions (WxHxD):	482 x 147 x 345 mm (19" x 5-13/16" x 13-9/16")
Weight:	19-13/16 lbs. (9 kg) net

ELECTRICAL

Line Input 1, 2:	
Input Impedance:	50k ohms unbalanced
Maximum Source Impedance:	10k ohms or less
Nominal Input Level:	-14 dBV (190 mV)
Minimum Input Level:	-24 dBV (60 mV)
Line Output:	
Minimum Load Impedance:	25k ohms or more, unbalanced
Output Impedance:	3.5k ohms or less
Nominal Output Level:	-10 dBV (0.3 V)
Maximum Output Level:	-7.5 dBV (0.42 V)
Headphone Output:	100 mW Maximum at 8 ohms
Bias Frequency:	100 kHz
Equalization:	1-7/8 ips 3180 μ s. + 70 μ s.
	3180 μ s. + 120 μ s. switchable
	3-3/4 ips 3180 μ s. + 35 μ s.
	3180 μ s. + 50 μ s. switchable
Frequency Response ³⁾	1-7/8 ips 35 Hz — 14 kHz ± 3 dB at -20 VU
(Record/reproduce):	35 Hz — 6.3 kHz ± 3 dB at 0 VU
	3-3/4 ips 35 Hz — 20 kHz ± 3 dB at -20 VU
	35 Hz — 15 kHz ± 3 dB at 0 VU
Total Harmonic Distortion (THD) ³⁾ :	1% at 0 VU, 1 kHz, 160 nWb/m
	1-7/8 ips 3% at 9 dB above 0 VU, 1 kHz, 451 nWb/m
	3-3/4 ips 3% at 10 dB above 0 VU, 1 kHz, 506 nWb/m
Signal to Noise Ratio ³⁾ :	At a reference of 3% distortion level
	1-7/8 ips 58 dB weighted
	55 dB unweighted
	92 dB weighted with DBX
	3-3/4 ips 63 dB weighted
	58 dB unweighted
	92 dB weighted with DBX
Adjacent Channel Separation:	Better than 35 dB at 1 kHz
Erase:	Better than 65 dB at 1 kHz + 10 VU reference
Headroom:	
Recording Amplifier:	Better than 19 dB above 0 VU
Reproduce Amplifier:	Better than 19 dB above 0 VU
Power Requirements:	100/120/220/240 V AC, 50/60 Hz, 41 watts (General Export Model),
	120 V AC, 60 Hz, 41 watts (U.S.A./Canada Model),
	220 V AC, 50 Hz, 41 watts (Europe Model),
	240 V AC, 50 Hz, 41 watts (U.K./Australia Model)

In these specs. 0 dBV is referenced to 1 V.

1) Specifications were determined using TEAC Test Tape MTT-111.

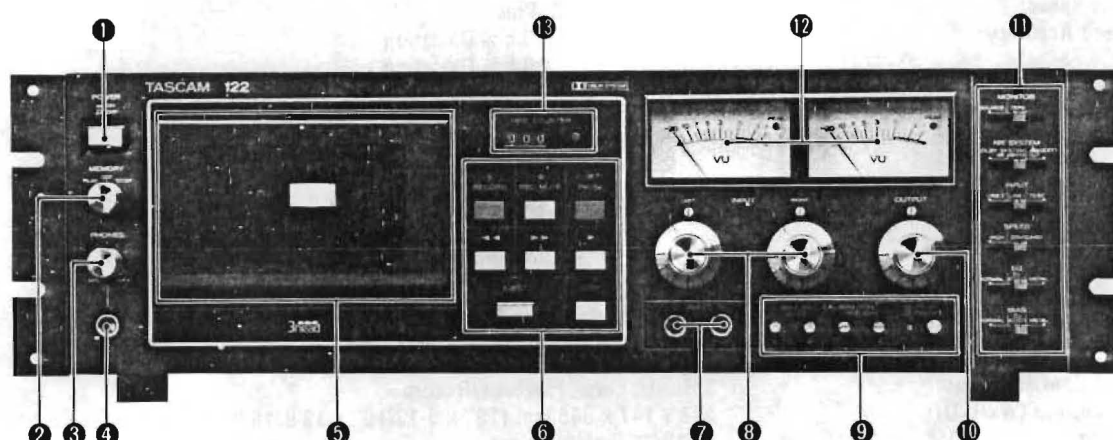
2) Specifications were determined using TEAC Test Tape MXT-111.

3) Specifications were determined using TEAC Test Tape MTT-506.

Changes in specifications and features may be made without notice or obligation.

2. FEATURES AND CONTROLS

2-1. FRONT PANEL FEATURES AND CONTROLS



① POWER switch

② MEMORY switch

This works in conjunction with the TAPE COUNTER and rewind function to rewind to any required part of the tape. The tape will be rewound to the 000 position on the tape counter (actually to 999, just past the 000 position). The 000 position can be reset at any position on the tape by pressing the reset button. If the MEMORY switch is in the STOP position, when the rewind (◀) button is pressed, the tape will be rewound until the counter has counted down to 999 (just beyond 000) and the tape will stop automatically. If the MEMORY switch is in the PLAY position, when the counter has counted down to 999, the tape will stop and then be played back automatically.

③ PHONES control

Adjusts the output volume for the headphones.

④ PHONES jack

Suitable for 8-ohm stereo headphones.

⑤ Cassette holder

The face plate of this door can be removed for easy access to the heads for cleaning, etc.

⑥ Transport controls

▶ (Play) button

◀◀ (Rewind) button

▶▶ (Fast Forward) button

STOP button

EJECT button

RECORD button

PAUSE button

REC MUTE (Record Muting) button

If the REC MUTE button is pressed while a recording is being made, only an erase signal is applied to the tape.

To release the record muting mode, press either the play (▶) or PAUSE button.

⑦ INPUT LINE 2 jacks

This pair of RCA jacks is provided as a convenience, and duplicates the function of the rear (LINE 1) input jacks for connecting a receiver or other line level source to the 122.

⑧ INPUT (LEFT, RIGHT) controls

These controls are used to adjust the levels of the left and right input signals to be recorded on the tape. The left and right controls are geared together to allow simultaneous adjustment of both channels. To adjust one channel independently of the other (to alter the channel balance), hold one knob while turning the other.

⑨ BIAS/REC CALIBRATION trimmers and button switch

With the button in the PRE-SET (out) position, the bias levels suitable for recording on normal, cobalt (Co), chromium dioxide (CrO₂) and metal tape can be selected using the BIAS switch, while the reference recording level is adjusted to match the average sensitivity for each type of tape. These factory-preset levels are average values for the three types of tape. For precise calibration of the bias and recording levels to exactly match a specific tape, set the button to the ADJUST (in) position and adjust the trimmers using a screwdriver.

⑩ OUTPUT control

This knob is used to adjust the level of the signals delivered from the OUTPUT jacks on the rear panel. Both channels are adjusted together. The readings of the VU meters are not affected by this control.

⑪ Function switches

MONITOR switch

This switch selects the signals fed to the headphones (PHONES) jack and the OUTPUT jacks, and is indicated by the VU meters.

SOURCE: Selects the input connected to the LINE 1 (rear) or LINE 2 (front) jacks. The levels displayed by the VU meters depend on the setting of the INPUT controls.

TAPE: Selects the signal from the tape. The levels displayed by the VU meters are the levels of the signals recorded on the tape; they are not affected by the setting of the OUTPUT control.

Note: For tape playback the MONITOR switch must be in the TAPE position.

NR SYSTEM switch

DOLBY SYSTEM/NR: Selects the built-in Dolby Noise Reduction circuit. This position is used to make a Dolbyized recording or to reproduce a Dolby-encoded cassette.

DOLBY SYSTEM/NR + HX: Selects the Dolby Noise Reduction circuit and also the Dolby Headroom Extension (HX) circuit which gives greater headroom in recording. Tapes recorded with the switch in this position can be played back with the switch in the same position or in the DOLBY SYSTEM/NR position.

dbx (EXT)/OUT: Use this position to record or reproduce without noise reduction or when USING THE OPTIONAL RX-8 DBX NOISE REDUCTION UNIT.

INPUT switch

This switch selects the signals fed to the recording circuit for recording.

LINE 1: Selects the signals applied to the rear panel LINE IN jacks.

LINE 2: Selects the signals applied to the front panel LINE 2 jacks.

TEST: Use this position when setting the bias and recording level calibration controls using a separate signal generator.

SPEED switch

HIGH: Selects a tape speed of 3-3/4 ips.

STANDARD: This selects the normal cassette tape speed of 1-7/8 ips.

EQ switch

Selects the equalization characteristics of the 122 to match the type of tape being used.

NORMAL: The equalization is 120 μ s.

Co (CrO₂): The equalization will match cobalt or chromium dioxide tape.

METAL: The equalization will match metal tape.

Note: The EQ switch should be set to match the tape for both recording and playback.

BIAS switch

Selects the factory-preset bias levels to match the type of tape being used for recording (with the BIAS/REC CALIBRATION button in the PRE-SET position).

NORMAL: The bias will match normal low-bias tape.

Co (CrO₂): The bias will match cobalt or chrome-equivalent tape.

METAL: The bias will match metal tape.

Note: The bias has no effect during playback, but it must be set correctly when recording to get optimum performance from the tape being used.

⑫ VU meters

A PEAK LED is provided in each meter; this lights to warn of overload at +8 dB input level which could result in distorted recording.

⑬ TAPE COUNTER

2-2. REAR PANEL CONNECTIONS

OUTPUT (R, L) jacks

LINE 1 (R, L) jacks

DBX UNIT terminals

These eight RCA pin-terminals are used for the connection of the optional RX-8 dbx noise reduction unit. If the RX-8 is not used, the U-link plugs provided must be left in place.

DBX UNIT CONTROL SIGNAL socket

This is a special socket which feeds the control signal to the optional RX-8 dbx noise reduction unit.

REMOTE CONTROL socket

Allows connection of the optional TEAC RC-90 Remote Control unit.

3. CIRCUIT DESCRIPTION

- The following conditions are assumed:
- * The deck is initially in the stop mode unless otherwise specified.
 - * Voltages, waveforms, and operating times given in the text are typical ones for reference.
 - * In the description of amplifiers (sections 3-11 through 3-14), generally, the left channel is described.
 - * In the illustrations, circuit boards, terminals, and connectors are omitted.
 - * Part numbers are assigned as follows:
 - 100–199: Muting circuit, bias oscillator circuit, and L-channel record/reproduce circuit mounted on record/reproduce & control PCB
 - 200–299: R-channel record/reproduce circuit on record/reproduce & control PCB
 - 300–399: L-channel monitor, record, and HX circuits and common L- and R-channel circuits mounted on lever switch PCB
 - 400–499: R-channel monitor, record, and HX circuits mounted on lever switch PCB
 - 500–599: Power supply PCB circuits.
 - 600–699: System control circuits and mechanical parts mounted on record/reproduce & control PCB and joint PCB

- 700–799: L-channel meter circuit and phone amplifier circuit mounted on meter amplifier PCB
- 800–899: R-channel meter circuit and phone amplifier circuit mounted on meter amplifier PCB

CONTROL SECTION

3-1. SYSTEM CONTROL IC

3-1-1 Pin assignments

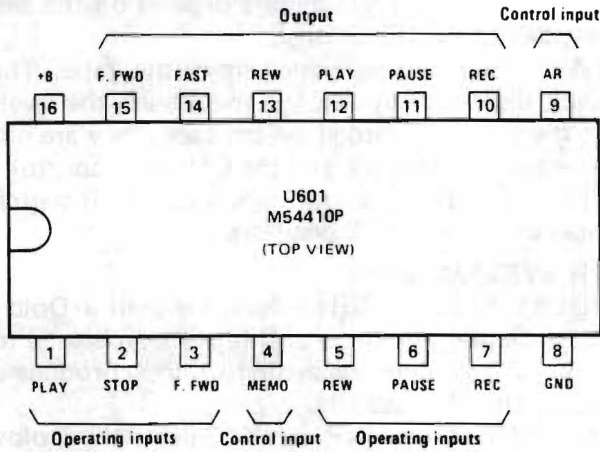


Fig. 3-1 Pin assignments

	Pin No.	Pin name	Function
Operation inputs	1	PLAY	Reproduce start signal input terminal. Signal level: L
	2	STOP	Stop signal input terminal. Signal level: L
	3	F.FWD	Fast-forward signal input terminal. Signal level: L
	5	REW	Rewind signal input terminal. Signal level: L
	6	PAUSE	Pause signal input terminal. Signal level: L
	7	REC	Record signal input terminal. Signal level: L
Control inputs	4	MEMO	Memory input terminal (resets rewind mode when at L level)
	9	AR	Record inhibit signal input terminal (L level: record inhibited, H level: record enabled)
Outputs power	10	REC	H-level signal output terminal during record/reproduce or record/pause mode
	11	PAUSE	H-level signal output terminal during pause mode
	12	PLAY	H-level signal output terminal during reproduce mode.
	13	REW	H-level signal output terminal during rewind mode.
	14	FAST	H-level signal output terminal during rewind or fast-forward mode.
	15	F.FWD	H-level signal output terminal during fast-forward mode.
Power	8	GND	Ground terminal.
	16	+B	Power supply terminal (standard: +5 V +/- 10%, absolute maximum: +7.0 V)

3-1-2 Block diagram

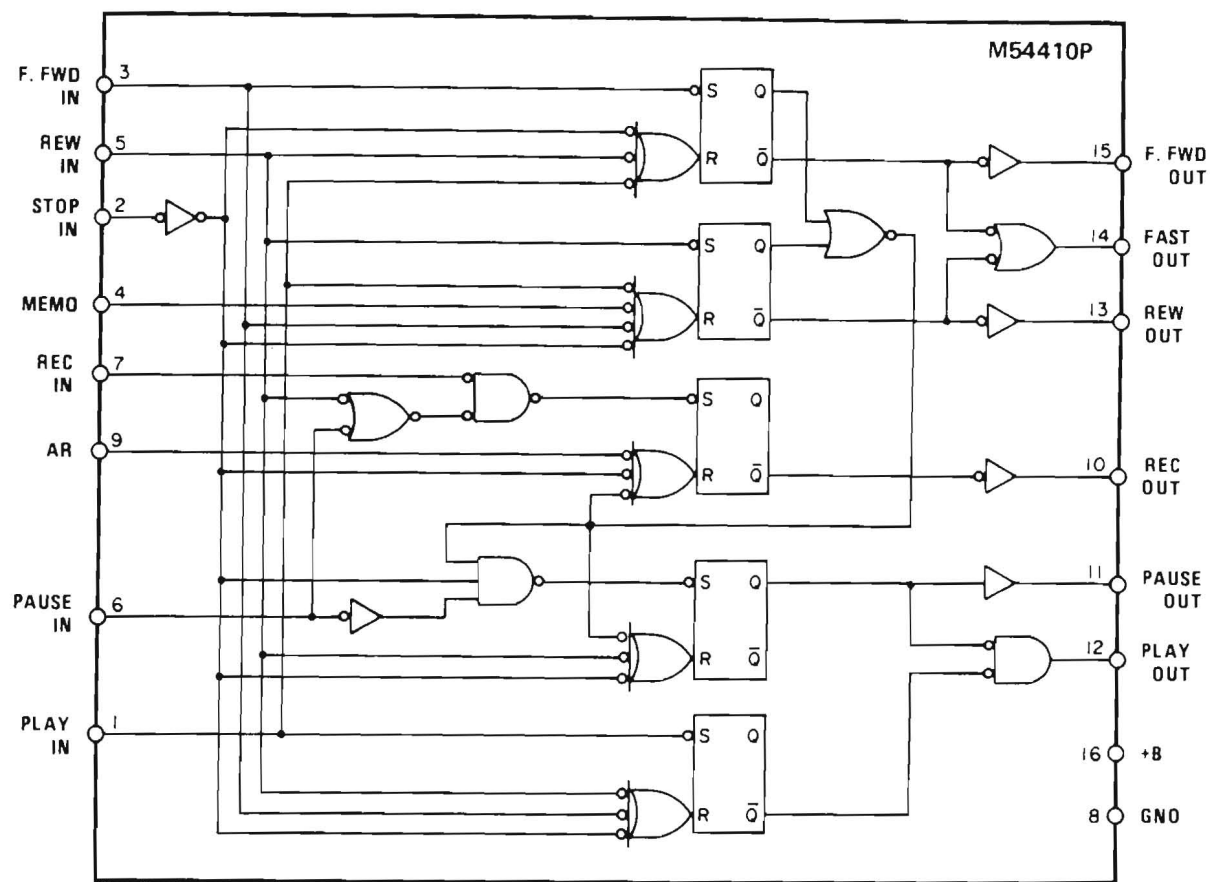


Fig. 3-2 Block diagram

3-1-3 Input signals and resulting modes

Output signal Input signal	REC	PAUSE	PLAY	REW	FAST	F. FWD	Operating mode
PLAY	L	L	H	L	L	L	PLAY mode
STOP	L	L	L	L	L	L	STOP mode
F.FWD	L	L	L	L	H	H	F.FWD mode
REW	L	L	L	H	H	L	REW mode
PAUSE	L	H	L	L	L	L	PAUSE mode
REC and PLAY	H	L	H	L	L	L	REC/PLAY mode
REC and PAUSE	H	H	L	L	L	L	REC/PAUSE mode

- Notes 1. The mode is set at the decaying edge of the input signal waveform.
2. The output retains the current mode until an input signal indicating a different mode is received.
3. Output REC remains at L as long as input AR is L.
4. Output REW remains at L as long as input MEMO is L.

3-1-4 Mode transition

The table below summarizes transition from one to another due to an input signal.

Current Mode Input signal	STOP	F.FWD	REW	PLAY	PAUSE	REC/PLAY	REC/PAUSE
STOP		STOP	STOP	STOP	STOP	STOP	STOP
F.FWD	F.FWD		F.FWD	F.FWD	F.FWD	F.FWD	F.FWD
REW	REW	REW		REW	REW	REW	REW
PLAY	PLAY	PLAY	PLAY		PLAY		REC/PLAY
PAUSE	PAUSE			PAUSE		REC/PAUSE	
REC and PLAY	REC/PLAY	REC/PLAY	REC/PLAY	REC/PLAY	REC/PLAY		REC/PLAY
REC and PAUSE	REC/PAUSE			REC/PAUSE	REC/PAUSE	REC/PAUSE	

Note. A diagonal line indicates that the current mode remains unchanged.

3-1-5 Operation with more than one input signal

When more than one input signal is received simultaneously, the deck enters the mode indicated below. When input signals applied simultaneously are removed in sequence, the mode indicated by the last signal to be removed is normally enabled. If REC and PLAY or REC

and PAUSE are combined, the record/reproduce or record/pause mode will be enabled regardless of the sequence in which the input signals are removed. If F.FWD (REW) and REC or PAUSE are combined, the fast-forward (rewind) mode will be enabled regardless of the sequence in which the input signals are removed.

Input signal A	Input signal B	Resulting mode
STOP	Any combination of F.FWD, REW, REC, PAUSE, and PLAY	STOP mode
F.FWD	REW	STOP mode
	REC and/or PAUSE	F.FWD mode
	PLAY	STOP mode
REW	REC and/or PAUSE	REW mode
	PLAY	STOP mode
REC	PAUSE	REC/PAUSE mode
	PLAY	REC/PLAY mode
	PAUSE and PLAY	REC/PAUSE mode
PAUSE	PLAY	REC/PLAY mode

3-1-6 Input/output levels

Input/output levels and voltages are given below.

Item	Minimum	Standard	Maximum	Absolute maximum
Maximum supply voltage	—	—	—	7.0 V
Maximum input voltage	—	—	—	5.5 V
Recommended supply voltage	4.5 V	5.0 V	5.5 V	—
H-level input voltage	2.0 V	—	—	—
L-level, input voltage	—	—	0.8 V	—
Open-input voltage	3.2 V	—	—	—
H-level output voltage	2.9 V	—	—	—
L-level output voltage	—	—	0.4 V	—

3-2-2 Output control circuit

When power is turned on, the initial reset circuit puts U601 in the stop mode. This circuit does not operate when power is turned off.

When power is cut off and +5.3 V is decaying, U601 may generate a wrong signal momentarily due to deviation from the logic threshold level. The circuit comprising Q606, D605, R629, and R630 prevents the mis-operation of the deck if U601 generates an incorrect signal.

When +5.3 V supply voltage falls to approximately 5 V after power is turned off, zener diode D605 turns off and, therefore, Q606 turns off together because its base current is cut off. As Q606 is off, the emitters of transistors Q601 – Q605 are disconnected from the 0 V (GND) line. As a result, Q601 – Q605 will not turn on even if U601 generates an incorrect signal while +5.3 V supply voltage is falling. This protects the deck from erroneous operation.

Further, if power is turned off when the deck is operating in any mode, the deck enters the stop mode as soon as Q606 turns off, preventing the tape from becoming slack.

On the other hand, when power is turned on, D605 and D606 do not go on until the +5.3 V line rises to approximately 5 V. Q601 – Q605 do not operate before Q606 is turned on. This means the deck does not start to operate before the DC supply voltage is sufficiently high.

3-3. SOLENOID DRIVE CIRCUIT

3-3-1 Functions of solenoids

There are three solenoids in the deck; fast solenoid (L691), head base solenoid (L692), and pinch roller solenoid (L693). These solenoids have specific functions and operate in certain modes as described below.

1) Fast solenoid (L691)

This operates in the fast-forward and rewind modes to perform the following mechanical functions.

- Releasing brakes applied to the left and right reel disks.
- Disengaging the reel disk drive gear from the right-hand (takeup) reel disk and locking the intermediate pulley assembly in the fast-forward position.

2) Head base solenoid (L692)

This operates in the reproduce, pause, record/reproduce, and record/pause modes to perform the following mechanical functions.

- Raising the head base to bring the erase and record/reproduce heads into close contact with the tape.

- Lifting the pinch roller to the pause position. (The pinch roller does not press against the capstan shaft in this position.)
- Releasing brakes applied to the left and right reel disks.

3) Pinch roller solenoid (L693)

This operates in the reproduce and record/reproduce modes to bring the pinch roller (raised to the pause position by the head base solenoid) into contact with the capstan to cause the tape to run at constant speed.

3-3-2 Fast solenoid drive circuit

See Fig. 3-4.

When the deck is in the stop mode, the circuit shown in Fig. 3-4 is as follows:

- * Pin 14 of U601: L level
- * Q605, Q515, Q516, Q518: off
- * Emitter of Q515: +13 V is applied via D506.

During fast (fast-forward or rewind) mode, a fast mode signal (H level) is output from pin 14 of U601. This signal causes fast solenoid L691 to operate in the following sequence.

- a. As pin 14 of U601 is at H level, base current flows through transistor Q605 and turns it on.
- b. As Q605 is on, base current flows through transistor Q515 and turns it on.
- c. As Q515 is on, current flows via paths ① and ②. (The supply voltage that causes current to flow via paths ① and ② is low and therefore the current on path ① cannot energize the fast solenoid.)
- d. The current on path ② (which charges capacitor C516) causes transistor Q516 to turn on.
- e. As Q516 is on, base current flows through transistor Q518 and turns it on.
- f. As Q518 is on, current flows via paths ③ and ④. At this time, the supply voltage that causes current to flow is +39 V and therefore a large amount of current flows through the fast solenoid (via path ③) to energize it.
- g. The current on path ④ charges C516 and it stops flowing when C516 is fully charged. Since the base current of Q516 is cut off, it turns off. The time interval between the turning on of Q515 and the turning off of Q516 (i.e., the time taken to charge C516) is approximately 100 msec which is determined by the time constant of capacitor C516 and resistor R536.
- h. As Q516 is off, Q518 turns off because its base current is cut off. In this way the current on path ③ is cut off.

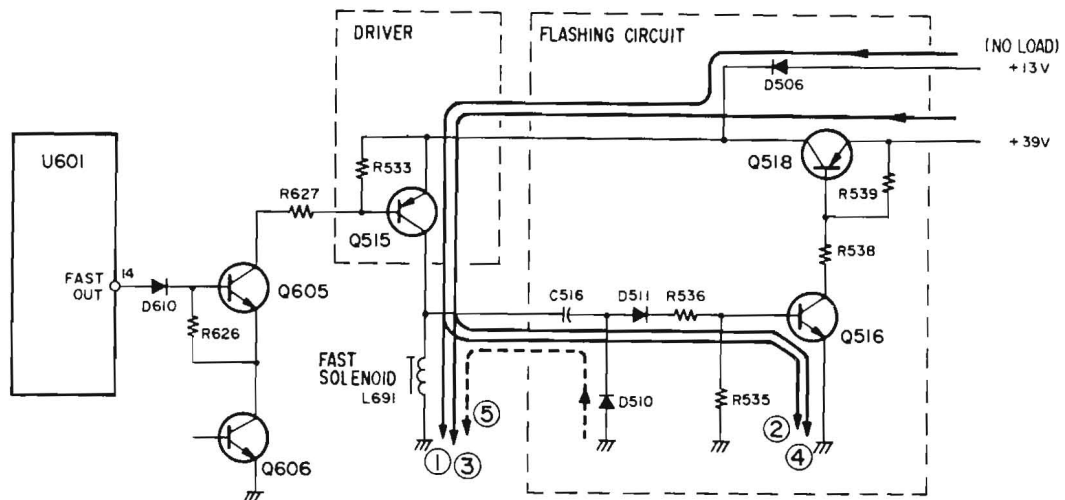


Fig. 3-4 Fast solenoid drive circuit

- i. Current is still flowing through the fast solenoid via path ① even though path ③ is cut off. Once the fast solenoid is energized by the strong current on path ③, this weak current flowing via path ① can hold it on.

Thus a high voltage (strong drive current) is supplied to the solenoid when energizing it while a low supply voltage (weak current) hold it on. This ensures solenoid operation by generating a strong mechanical force and prevents the solenoid from heating up by reducing the holding current.

The circuit which switches the supply voltage of the solenoid is called the flashing circuit.

When a fast mode is released (the STOP button is depressed during fast-forward or rewind mode), the following sequence of operations takes place.

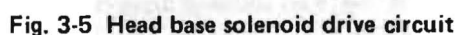
- j. As soon as a fast mode is released, pin 14 of U601 turns to L level.
 k. Q605 turns off, because its base current is cut off.
 l. As Q605 is off, Q515 turns off, as its base current is cut off.
 m. As Q515 is off, the solenoid is reset, because its holding current which was flowing via path

① is cut off. At the same time, C516 discharges via path ⑤ to prepare for the subsequent start of a fast mode.

3-3-3 Head base solenoid drive circuit

See Fig. 3-5.

The head base solenoid operates during the reproduce (record/reproduce) and pause (record/pause) modes. In the reproduce mode, a reproduce mode signal (H level) is output from pin 12 of U601. In the pause mode, a pause mode signal (H level) is output from pin 11 of U601. In both cases, the H-level signal causes base current of transistor Q601 to flow so it is turned on. The part of the head base solenoid drive circuit after Q601 is exactly the same as the fast solenoid drive circuit described in the previous section. Since these circuits operate in the same way, the description is not repeated. Note that the time during which the solenoid is energized by the high voltage from the flashing circuit (capacitor C516 and resistor R536 determine this) is approximately 400 msec, longer than the 100 msec of the fast solenoid. The reason is to ensure operation of the head base solenoid as its mechanical load is much greater.



See Fig. 3-6.

Here, operation of the power delay circuit and reproduce delay circuit are described as they are not incorporated in solenoid drive circuits.

The positive side of capacitor C526 is connected to the output of the +23 V voltage regulator. This regulated +23 V is used as the power source for the amplifiers and also as a reference voltage for the power supplies which supply the control circuits, reel motor,

- When power has been turned on, the +23 V regulated power supply starts to work and its output voltage rises.
- As the output voltage rises, base current flows through transistor Q521 via capacitor C526 and resistor R547, turning it on.
- As Q521 is on, base current flows through transistor Q508 and turns it on.
- As Q508 is on, the base and emitter of pinch roller solenoid driver transistor Q509

are shorted. Therefore, base current does not flow to Q509 and it will remain off even if transistor Q602 turns on with a reproduce mode signal (H level) supplied from U601.

- e. When C526 is fully charged (in approximately 1.5 seconds) after power is switched on, the base current of Q521 stops and it turns off. (C526 and R547 provide the delay time of about 1.5 seconds.)
- f. As Q521 is off, Q508 turns off, having its base current cut off. Now Q509 is ready for operation. This process keeps the pinch roller solenoid inactive for approximately 1.5 seconds after power is switched on.

2) Reproduce delay circuit

The circuitry is designed so that, in the reproduce mode, the pinch roller solenoid operates after the head base solenoid has completed operation. The reproduce delay circuit delays pinch roller operation until the completion of the head base solenoid operation. Fig. 3-7 and 3-8 are a flowchart and timing diagram, respectively, of the process which begins with the output of a reproduce mode signal (H level) from pin 12 of the system control IC and ends with the energizing of the pinch roller solenoid. In Fig. 3-7, operations of the reproduce delay circuit are enclosed in bold boxes.

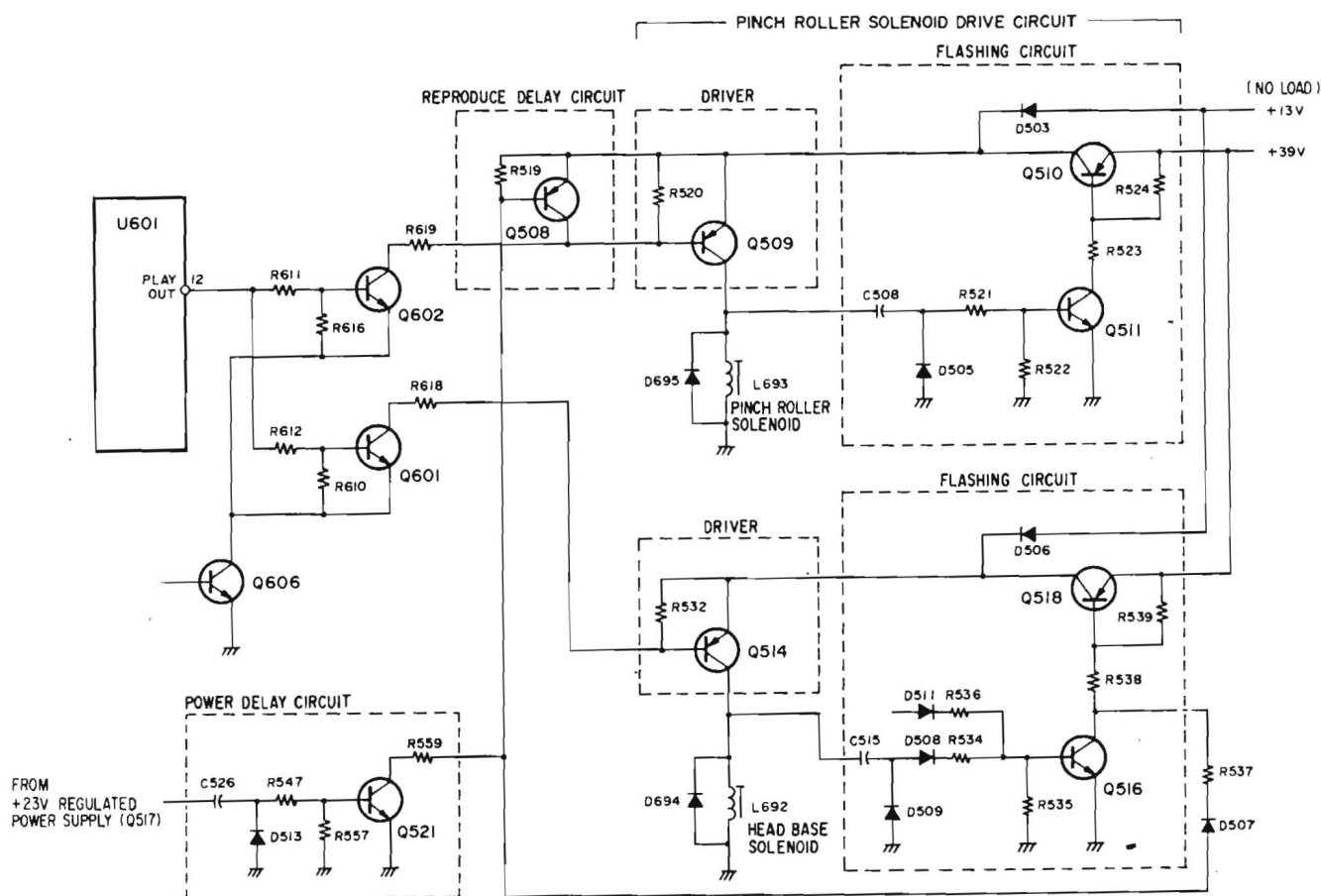


Fig. 3-6 Pinch roller solenoid drive circuit

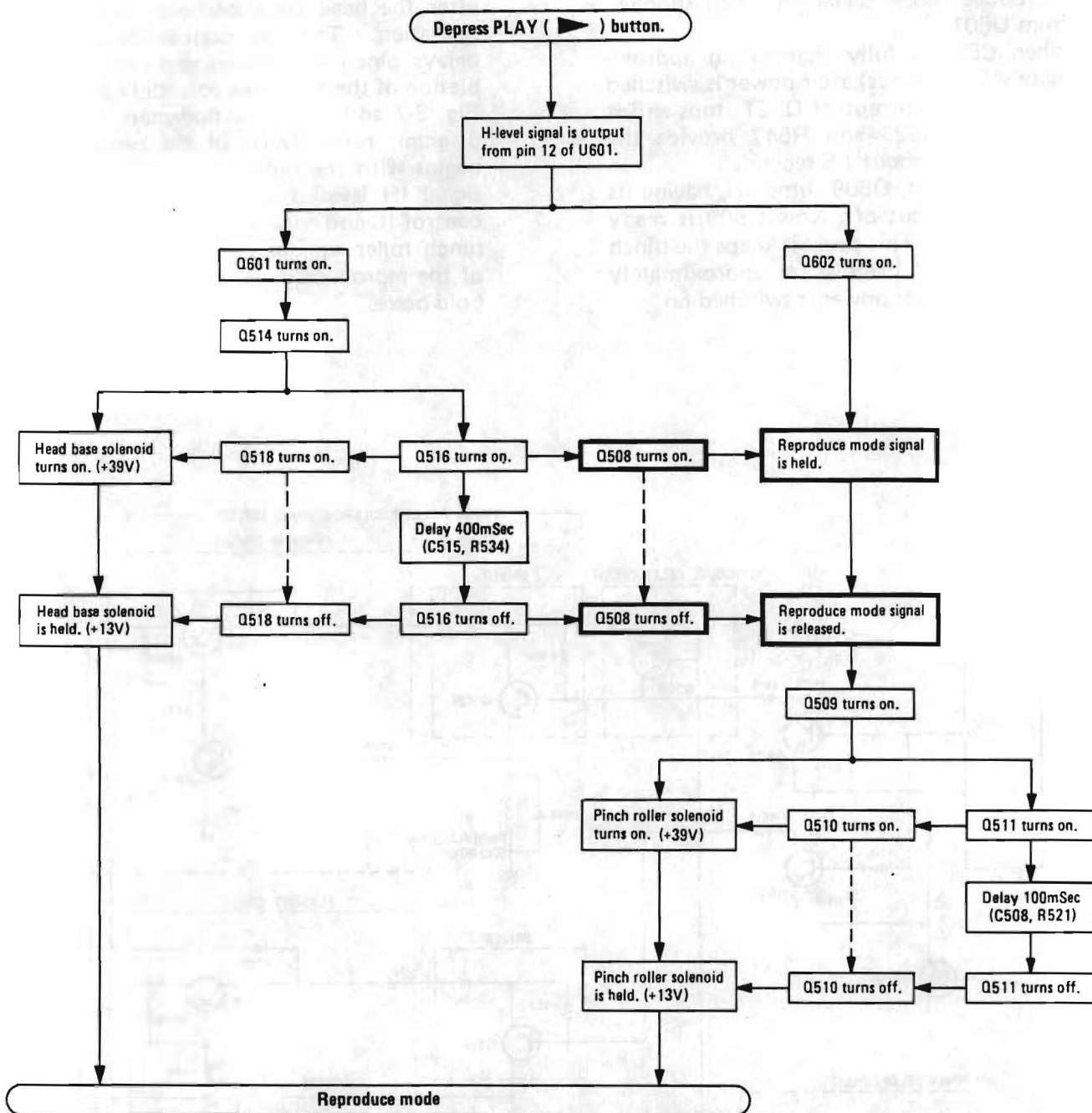


Fig. 3-7 Flowchart of solenoid operation (in reproduce mode)

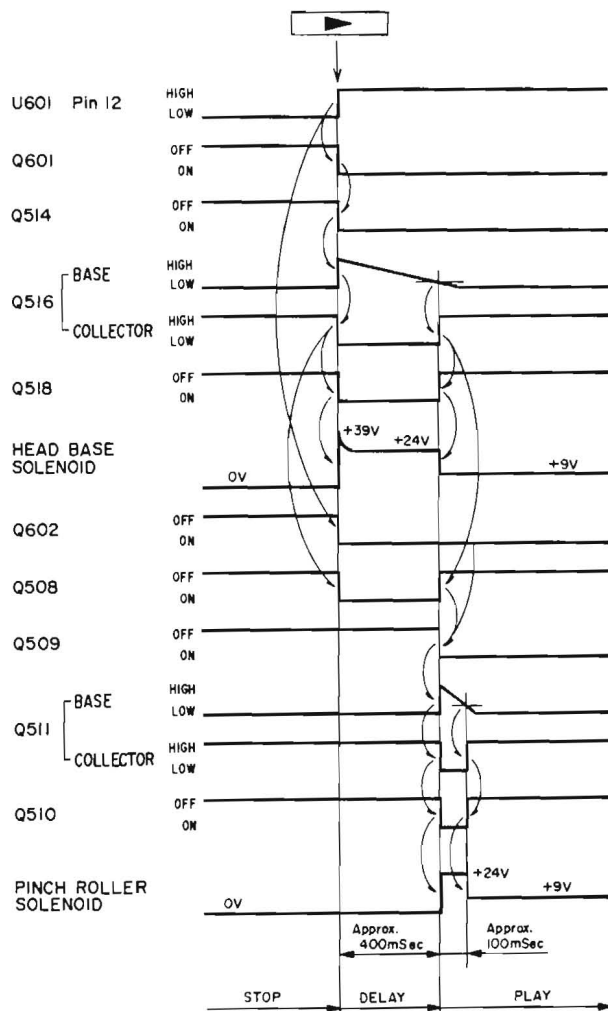


Fig. 3-8 Timing diagram of solenoid operation (in reproduce mode)

3-4. REEL MOTOR DRIVE CIRCUIT

3-4-1 Direction of motor rotation

The reel motor drives the left or right reel disk to take up the tape. Torque is transmitted from the reel motor to one of the reel disks during the reproduce, fast-forward, and rewind modes by the processes shown in Fig. 3-9 — 3-11 (as seen from the front of the deck). As seen from Fig. 3-9 and 3-11, the reel motor rotates in the same direction during the reproduce and rewind modes and the fast-forward pulley mechanically selects either the left or right reel disk and drives it in accordance with the direction of reel motor rotation. In the pause mode, the reel motor does not rotate.

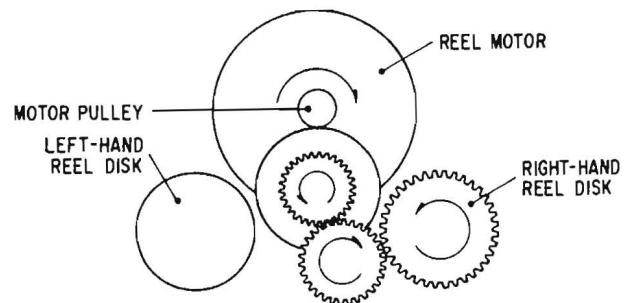


Fig. 3-9 Reel disk drive (reproduce mode)

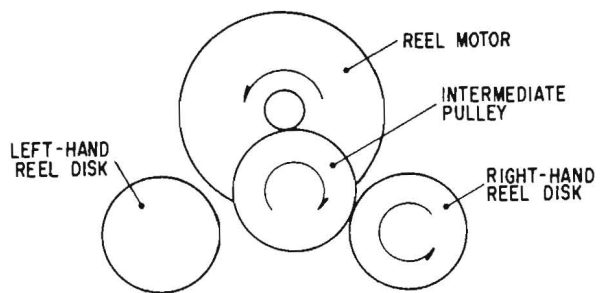


Fig. 3-10 Reel disk drive (fast-forward mode)

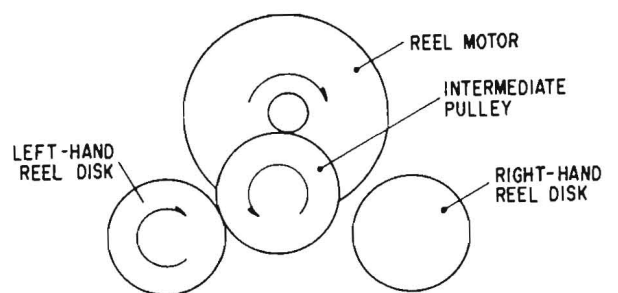


Fig. 3-11 Reel disk drive (rewind mode)

3-4-2 Reproduce mode

See Fig. 3-12.

When the deck is in the stop mode, base current is supplied to transistor Q505 via R510, turning it on. In the reproduce mode, the reel motor rotates in the following sequence.

- When a reproduce mode signal (H level) is output from pin 12 of U601, Q601 and Q602 turn on.
- Q601 activates the head base solenoid drive circuit. When the head base solenoid completes operation, Q508 turns off, permitting base current to flow through Q509 and turning it on.
- As Q509 is on, base current flows through Q501 and turns it on. At the same time, current flowing via path ① charges capacitor C504.
- As Q501 is on, base current flows through transistor Q504 via path ② and turns it on.
- As Q504 is on, current is supplied to the reel motor via path ③ and causes the motor to run. At this time, the supply voltage of +13 V is directly applied to the reel motor so that the motor drives the reel disk with a large starting torque so that the tape is tight.
- As current on path ① charges C504 and its charge rises, the voltage at the base of Q506 rises and its base current increases; Q506 is turned on completely in about 80 msec. Now the base current of Q505 decreases since its base level falls from +13 V, divided by R510

and R509. This results in a decrease in Q505's collector current (the current supplied to the motor) and in the voltage applied to the motor. Thus the torque of the motor is reduced and the reproduce mode is stabilized.

3-4-3 Rewind mode

See Fig. 3-12.

When the rewind mode has been enabled, a rewind mode signal (H level) is output from pin 13 of U601 and base current flows through Q501 via resistor R622, turning on Q501. Q504 turns on immediately since its base current flows along path ②. When Q504 is on, a large current is supplied to the reel motor via path ③, driving the motor at a high speed. During the rewind mode, Q506 remains off.

3-4-4 Fast-forward mode

See Fig. 3-13.

When the fast-forward mode has been enabled, a fast forward mode signal (H level) is output from pin 15 of U601 and base current of transistor Q502 flows via resistor R620, turning Q502 on. As Q502 is on, base current of transistor Q503 flows via path ①, turning Q503 on. Now +13 V is applied to the reel motor, the large current flowing via path ② causes the motor to run at a high speed. The direction of the current is reversed in the fast-forward mode to that in the reproduce and rewind modes so the direction of motor rotation is reversed.

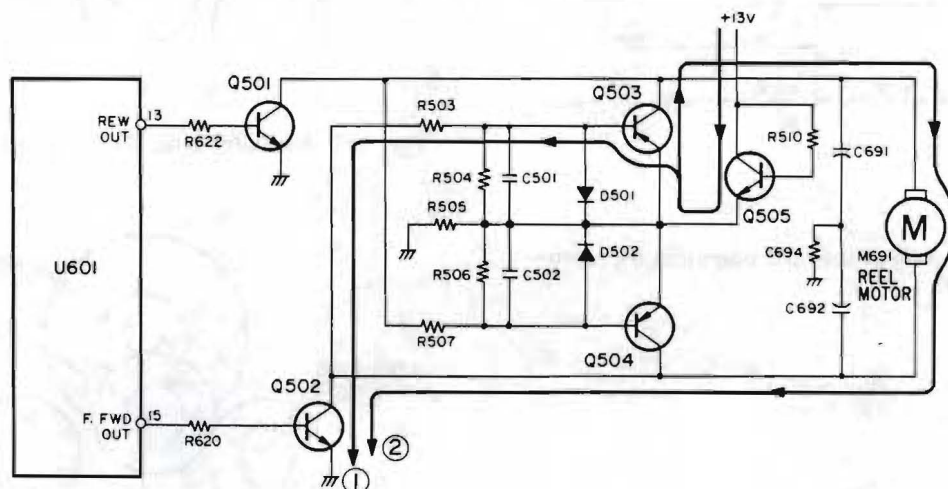


Fig. 3-13 Reel motor drive circuit (fast-forward mode)

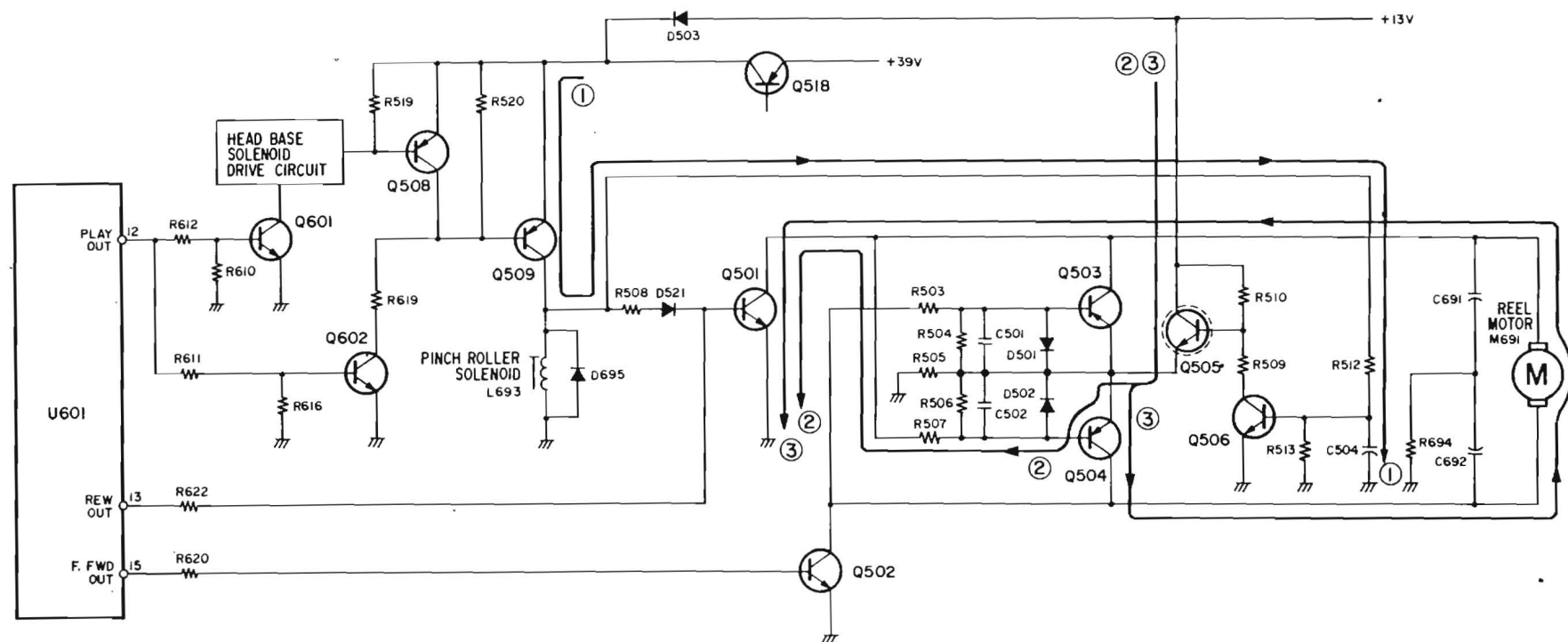


Fig. 3-12 Reel motor drive circuit (reproduce/rewind modes)

3-5. CAPSTAN MOTOR CIRCUIT

See Fig. 3-14.

The capstan motor rotates in the reproduce (record/reproduce) and pause (record/pause) modes. Its torque is transmitted to the flywheel by a belt to drive the flywheel and capstan shaft. In both the reproduce and pause modes, Q514 is on to energize the head base solenoid. When Q514 is on, base current flows through transistor Q692, turning it on. Now the 0 V line of the capstan motor servo amplifier is shorted to the ground line of the power supply circuit. The servo amplifier is activated and the motor starts to rotate. The speed of the capstan motor may be switched between 'standard' (tape speed: 4.76 cm/sec) and 'high' (9.5 cm/sec) by SPEED switch S4-2.

3-6 TAPE-END DETECTION CIRCUIT

See Fig. 3-15.

The ring magnet, shown in Fig. 3-15, is mounted on the counter pulley shaft and rotates while the tape is running. Variations in the magnetic field caused by the rotation of the ring magnet turn reed switch S693 on and off. This means that, when the tape is moving, the reed switch turns on and off repeatedly.

When the reed switch turns on while the tape is running, the charge from capacitor C609 flows through the base of transistor Q607 via path ③, turning it on. When the reed switch turns off, Q607 turns off, as its base current is cut off. At this time, C609 discharges via path ④. Thus, while the reed switch is turning on and off repeatedly, Q607 also turns on and off repeated-

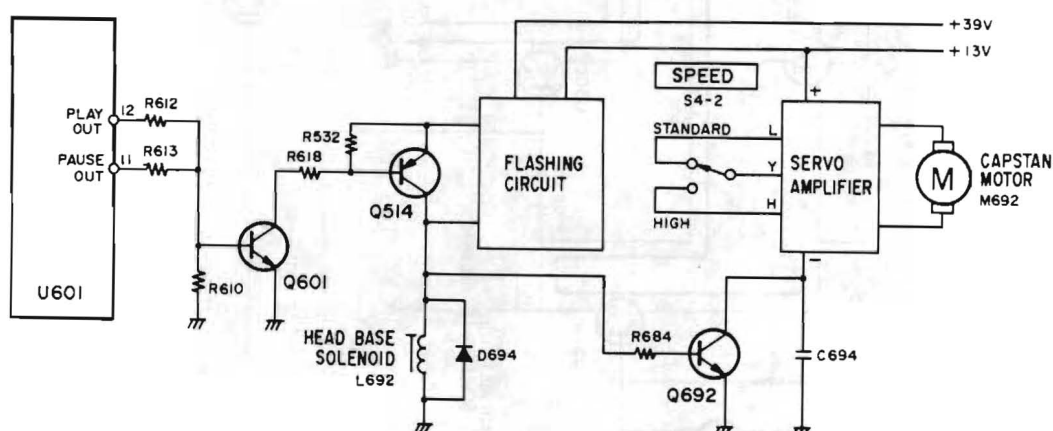


Fig. 3-14 Capstan motor circuit

ly. When Q607 is off, capacitor C610 is charged by current flowing via path ⑤. When Q607 is on, C610 discharges via path ⑥. Since the time constant of C610 and R631 is much smaller than that of C610 and R656 (or R657), the charging of C610 proceeds slowly while it discharges rapidly. As a result, the voltage at A remains below +1.5 V while Q607 is repeatedly turned on and off.

When the tape reaches its end and stops running, the counter pulley and the ring magnet stop rotating. At this time, the reed switch stops operating in either its on or off position depending on where the ring magnet has stopped. If the reed switch is on, the base current of Q607 stops flowing turning it off, and current flowing along path ⑤ starts to charge C610 as soon as

current from path ③ completes charging C609. If the reed switch is off, Q607 is already off because the reed switch has turned off and, therefore, current from path ⑤ continues to charge C610.

When the voltage across C610 (voltage at A) exceeds approximately 3 V, base current flows through transistor Q513 via path ⑦, thereby turning on Q613. Q613 turns on approximately 2.3 seconds after Q607 turns off. Since Q613 turning on is equivalent to depressing the stop button, the deck enters the stop mode.

When the deck enters the stop mode, current on path ① or ② stops flowing and C610 discharges via R656 and the fast solenoid and via R657 and the pinch roller solenoid (current flows in the direction opposite to ⑤).

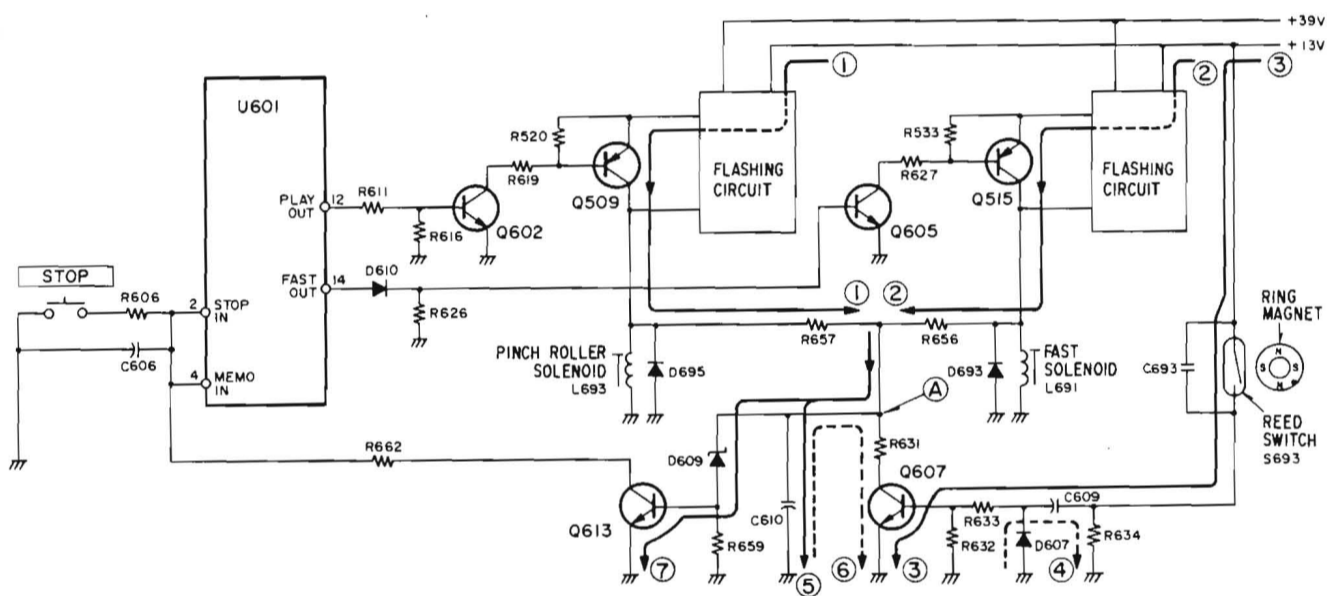


Fig. 3-15 Tape-end detect circuit

3-7. MEMORY CIRCUIT

See Fig. 3-16.

Counter switch S696 is linked to the counter and is closed when the counter reads between "900" and "999".

- When the deck is in the rewind mode, a rewind mode signal (H level) is output from pin 13 of system control IC U601.
- Therefore, current flows from pin 13 of U601 to charge C507 via R502 and R518. Charging takes place slowly because of the large charging time constant.
- The counter counts down as the tape is rewound and, when it reaches "999", S696 turns on.
- When S696 turns on, C507's charge flows to the base of Q691 via S696 and R691, turning Q691 on.
- If the MEMORY switch is set to STOP when Q691 has turned on, a stop signal (L level) is output from pin 2 (and pin 4) of U601 and the deck enters the stop mode.
- Pin 4 (MEMO IN) of U601 has the function that, if it becomes L level when U601 is in the rewind mode, the rewind mode will be released and the stop mode enabled. In the deck, this terminal is connected to the STOP IN terminal.
- If the MEMORY switch is set to OFF, the collector of Q691 is open and S696 is on. The tape will be rewound to the end and, when the tape-end detect circuit detects the tape end, the deck will enter the stop mode automatically.

h. If the MEMORY switch is set to PLAY when Q691 has turned on, a reproduce mode signal (L level) is output from pin 1 of U601 and the deck enters the reproduce mode.

i. The stop mode is entered automatically when the tape has been rewound to the end before the counter reaches "999", whether the MEMORY switch is set to STOP or to PLAY.

3-8. POWER SUPPLY CIRCUITS

3-8-1 Main regulator

See Fig. 3-17.

Transistors Q517, Q519, Q520, and zener diode D512 are the main components of the main regulator. The output of the main regulator is supplied to the amplifiers and also used as a reference voltage in the regulated power supplies of the motor and control circuits.

1) Equilibrium condition

- The secondary voltage of the power transformer is full-wave-rectified by rectifiers D541 – D544, then smoothed by capacitor C520.
- When power is not supplied to the regulated power supplies, Q517, Q519, and Q520 are off. (Q519 is the current amplifier that controls Q517 by amplifying variations of weak control current flowing through Q520 described later. Here, the operation of Q519 is not described.)
- When the power supply to the regulated power supplies starts, the base current of Q517 flows via path ①. Since Q520 is still off at this time, current flowing

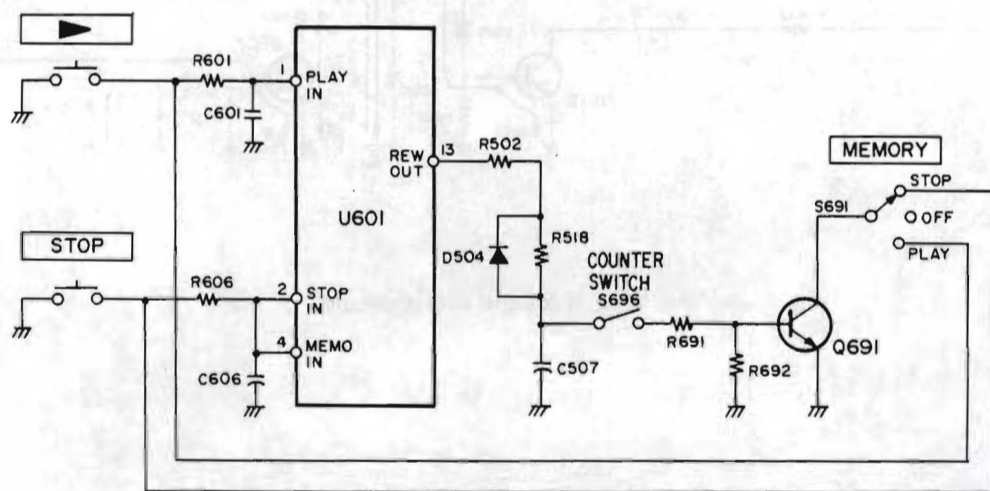


Fig. 3-16 Memory circuit

- through resistors R540 and R541 are input to the base of Q517, permitting a large collector current ② to flow through Q517. As a result, the output voltage rises rapidly.
- d. As the output voltage rises, current flows via paths ③ and ④. The emitter of Q520 is fixed at the zener voltage ($V_{ZD} \approx 13\text{ V}$) by current flowing along path ③ and the zener diode.
- e. If the output voltage rises for any reason and the current flowing along path ④ increases, the voltage drop across R544 increases and the base voltage of Q520 rises. When the base level exceeds the emitter level, collector current ⑤ begins to flow to Q520.
- f. The output voltage of the main regulator has been rising during this time. However, the collector current of Q520 works to reduce the output voltage because the current on path ① decreases.
- g. When the voltage difference between the base and emitter of Q520 reaches approximately 0.7 V, the main regulator enters a state of equilibrium. That is, drift of the current on path ① tending to raise the output voltage is cancelled by the tendency to reduce the output voltage because a rise of the output voltage results in an increase in the current of Q520, an increase of the current on path ⑤, and a decrease of the current on path ① in this sequence.

- h. In the state of equilibrium, the output voltage is determined by the following equation.

$$\frac{R544}{R542 + R544} \times V_{OUT} = V_{ZD} + V_{BE}$$

$$\therefore V_{OUT} = \frac{R542 + R544}{R544} \times (V_{ZD} + V_{BE})$$

Substituting the actual values of the circuit parameters, we have the output voltage as follows.

$$V_{OUT} = \frac{4.7\text{k}\Omega + 6.8\text{k}\Omega}{6.8\text{k}\Omega} \times (13 + 0.7) \approx 23.1\text{ V}$$

2) Regulating process

When the output voltage tends to rise (fall) because of reduced (increased) load, the following process stabilizes the voltage.

- The output voltage starts to rise (fall).
- The base level of Q520 rises (falls).
- Since the emitter of Q520 is kept at a fixed level, its base current increases (decreases) and the collector current ⑤ varies together with rising (falling) of the base level.
- As a result, the base current ① of Q517 decreases (increases) and its collector current varies similarly.
- Thus the output voltage falls (rises) to the initial level.

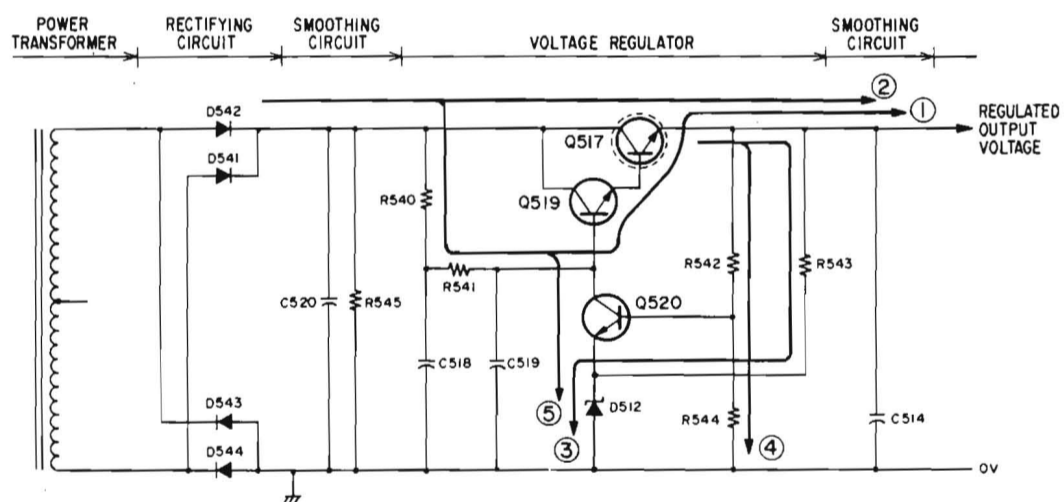


Fig. 3-17 Main regulator

3-8-2 DC power supply system

The DC power supply system is shown in Fig. 3-18. This comprises the main regulator described in the previous section and minor regulated power supplies from independent transistors Q512, Q513, and Q507. For these transistors, the +23 V regulated output of the main regulator is used as a reference voltage to simplify the circuitry.

The output voltages of the minor power supplies are roughly given by the following equations:

$$V_{OUT(Q512)} = \frac{R527}{R526 + R527} \times (+23V) - V_{BE}$$

$$V_{OUT(Q513)} = \frac{R530}{R529 + R530} \times (+23V) - V_{BE}$$

$$V_{OUT(Q507)} = \frac{R515}{R514 + R515} \times (+23V) - V_{BE}$$

where V_{BE} is 0.6 – 0.7 V.

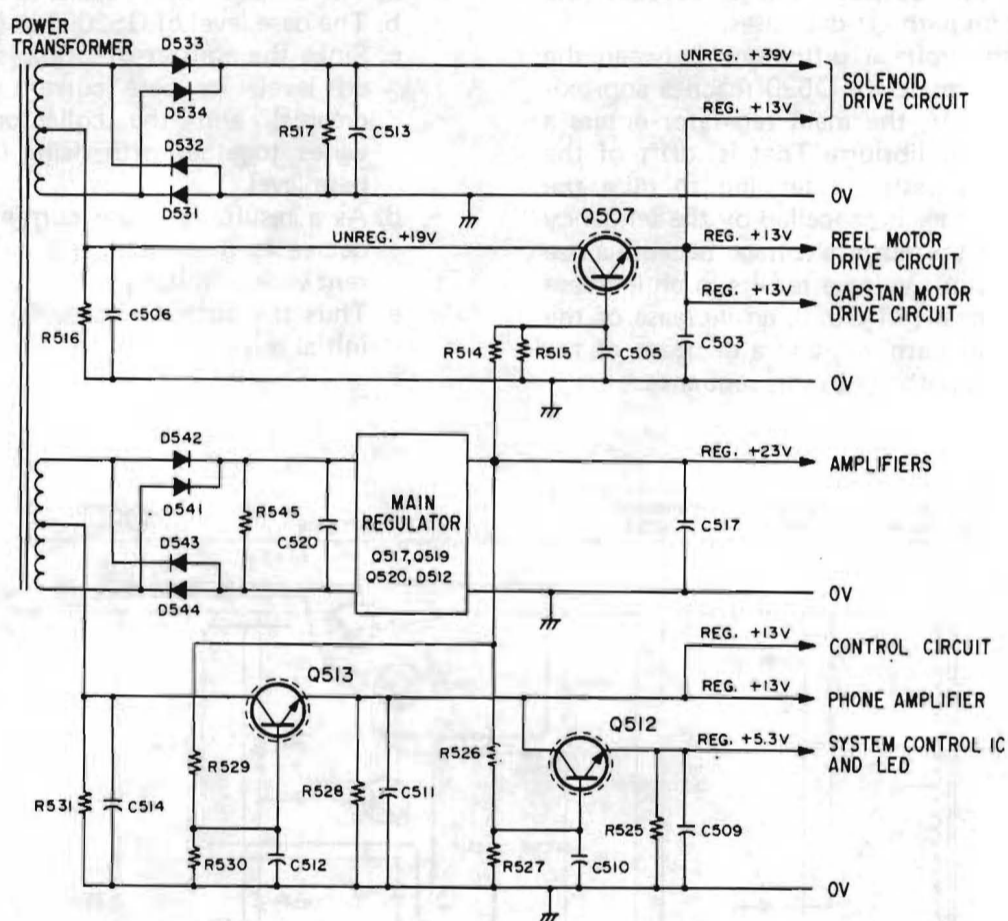


Fig. 3-18 DC power supply system

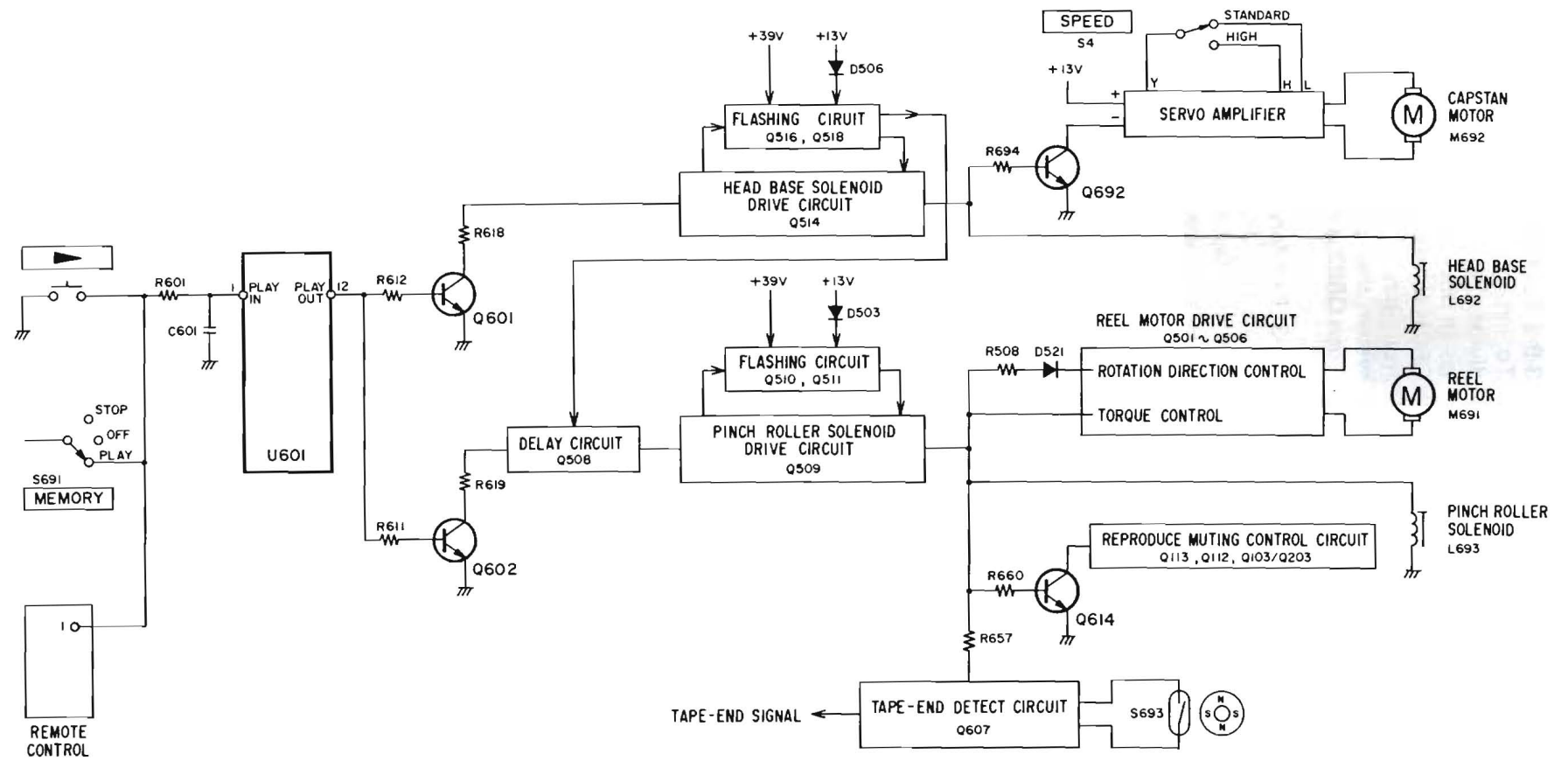


Fig. 3-19 Schematic of reproduce mode

3-9. OVERALL OPERATION OF THE DECK

We have so far seen the separate operations of control circuits, each with a specific function. This section briefly describes the overall operation of the deck operations in the reproduce, pause, fast-forward, and rewind modes. Refer to Section 3-10-3 for operation in the record mode.

3-9-1 Reproduce mode

See Fig. 3-19.

To explain operations in the reproduce mode, we divide the system into two subsystems. One is the head base subsystem that operates when Q601 is turned on by the H-level signal output from pin 12 of U601. The other is the pinch roller subsystem that operates, when Q602 is turned on.

1) Head base subsystem

This goes through the following steps when Q601 is turned on.

- a. The head base solenoid operates.
- b. A delay signal is applied to the pinch roller solenoid drive circuit via the flashing circuit of the head base solenoid.
- c. Q692 turns on and the capstan motor rotates.

2) Pinch roller subsystem

This goes through the following steps after a delay long enough for the operation of the head base solenoid following the turning on of Q602.

- a. The pinch roller solenoid operates.
- b. The reel motor rotates.
- c. The tape-end detection circuit becomes ready for operation.
- d. Q614 turns on and the reproduce amplifier is released from muting.

3-9-2 Pause mode

To explain operations in the pause mode, we divide the system into the head base subsystem (as in the reproduce mode) that operates, with Q601 turned on by the H-level signal output from pin 11 of U601, and the indicator subsystem that causes the PAUSE indicator to light when Q603 is on.

3-9-3 Fast-forward mode

In the fast-forward mode, we divide the system into the fast-forward subsystem that operates when an H-level signal is output from pin 15 of U601 and the fast subsystem that operates when an H-level signal is output from pin 14 of U601.

1) Fast-forward subsystem

The reel motor rotates.

2) Fast subsystem

- a. The fast solenoid operates.
- b. The tape end detection circuit becomes ready for operation.

3-9-4 Rewind mode

In the rewind mode, we divide the system into the rewind subsystem that operates when a H-level is output from pin 13 of U601 and the fast subsystem that operates when a H-level is output from pin 14 of U601.

1) Rewind subsystem

- a. The reel motor rotates.
- b. The memory circuit becomes ready for operation.

2) Fast subsystem

- a. The fast solenoid operates.
- b. The tape-end detection circuit becomes ready for operation.

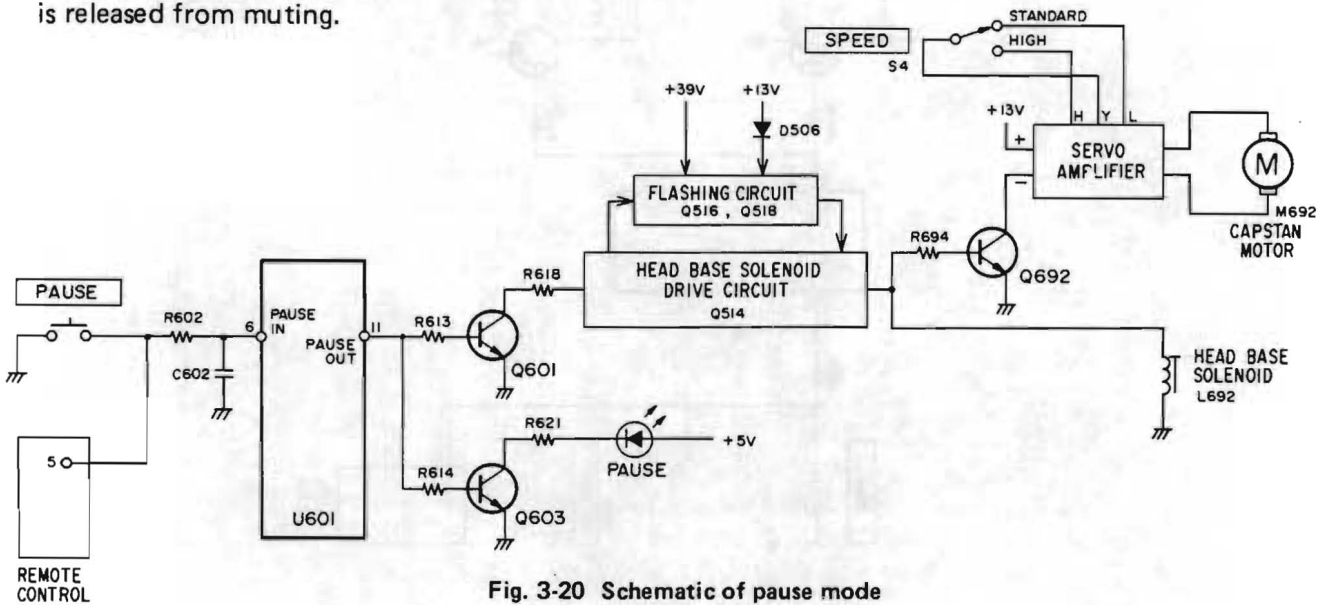


Fig. 3-20 Schematic of pause mode

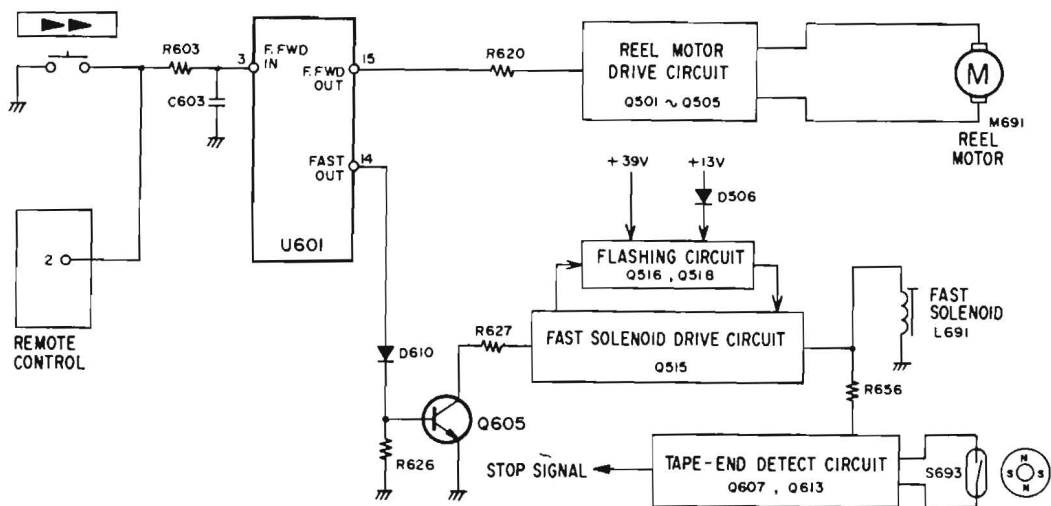


Fig. 3-21 Schematic of fast-forward mode

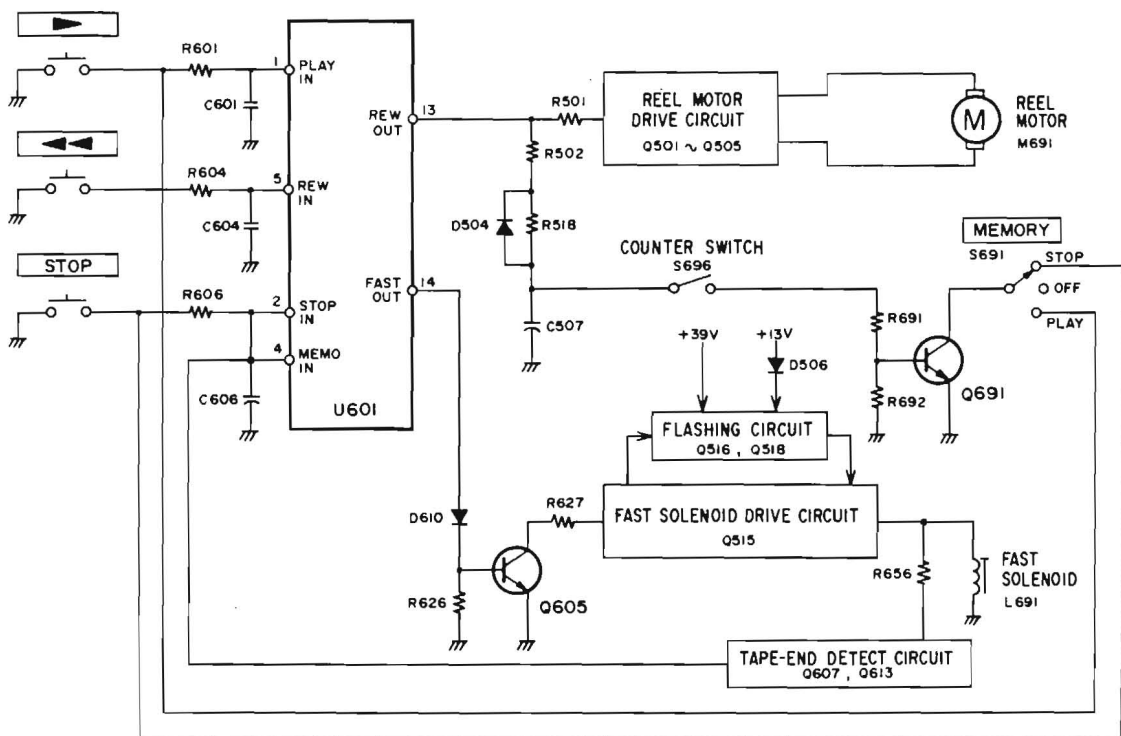


Fig. 3-22 Schematic of rewind mode

3-10. MUTING CIRCUITS

3-10-1 Power muting circuit

See Fig. 3-23.

The power muting circuit prevents transient click noise from being output from the OUTPUT and PHONES terminals and the VU meter needles from deflecting when the deck's power switch is turned on or off.

1) Power-on muting

When the deck power switch has been turned on, the power muting circuit operates as follows.

- When power has been turned on, the power muting circuit is supplied with 7 V AC. Diodes D516 and D515 half-wave-rectify the AC voltage, charging capacitors C524 and C523 via paths ① and ② momentarily. The voltage across C523 is divided by resistors R551 and R550 and is then applied to the emitter of transistor Q522.
- Capacitor C522 serves as a ripple filter together with R551.
- The charging of C521 starts via paths ③ and ④ when the circuit's power supply starts. Since the current on path ④ is the base current of transistor Q522, it turns on.
- As Q522 is on, base current flows through transistor Q104 via path ⑤, turning it on.

As Q104 is on, the signal line of the monitor circuit is shorted to ground to prevent the generation of click noise when power is switched on.

- When C521 is fully charged, Q522 turns off as its base current is cut off. Q104 turns off in the same way and, as a result, muting is released.

Releasing power muting takes place approximately 3.5 seconds after the deck power switch is turned on.

- When Q522 is off, -5.3 V is applied to the base of Q104 via R128 and R553. This ensures the off state of Q104.

2) Power-off muting

When the deck power switch has been turned off, the power muting circuit operates as follows.

- When power has been turned off, the supply of 7 V AC stops. C524 and C521 discharge rapidly through the meter lamp circuit via paths ⑥ and ⑦.
- Therefore, the base voltage of Q522 falls and its base current flows from C523 via path ⑧, turning it on.
- As Q522 is on, C523 discharges via path ⑨, turning on Q104 so that the power amplifier is muted.

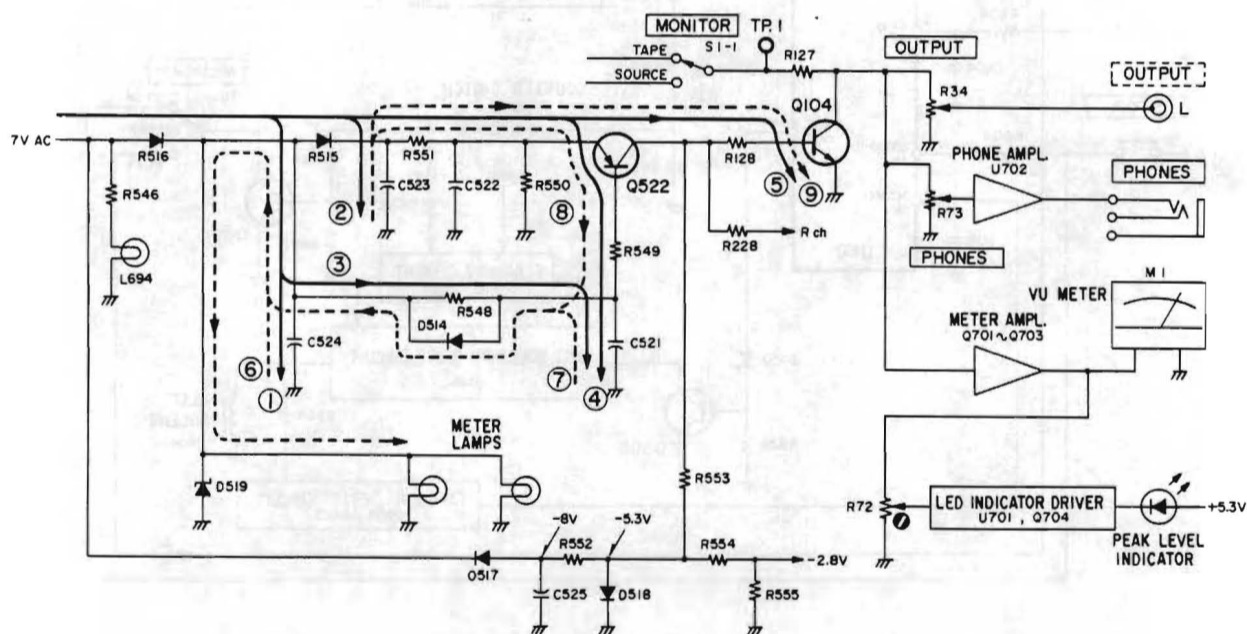


Fig. 3-23 Power muting circuit

3-10-2 Reproduce muting circuit

See Fig. 3-24.

The reproduce muting circuit mutes the reproduce equalizer amplifier to prevent the generation of undesirable noise in modes other than the reproduce mode.

1) Muting on

In a mode other than the reproduce mode (stop mode, for example), the reproduce muting circuit operates as follows to mute the reproduce equalizer amplifier.

- In the stop mode, the pinch roller solenoid drive transistor Q509 is off.
- Because of this base current is not supplied to transistor Q614 and it remains off.
- As Q614 is off, base current of Q113 flows via path ①, therefore it is on.
- As Q113 is on, base current of Q112 flows via path ② and it is on. At this time, capacitor C136 is charged to +23 V.
- As Q112 is on, the base current of Q103 flows via path ③ and it is on so the reproduce equalizer amplifier is muted. Because the signal level is low in the Q103 circuit its collector is grounded to reduce muting transistor switching noise.

2) Muting off

When pinch roller solenoid drive transistor Q509 turns on in the reproduce mode, muting is released by the following process.

- As Q509 is on, base current is applied to Q614 and it turns on.
- As Q614 is on, Q113 turns off as its base current ① is cut off.
- When Q113 is off, the base current ② applied to Q112 is cut off. Q112 does not go off immediately since C136's discharge current ④ flows to its base.
- As C136 discharges, its discharge current ④ (the base current of Q112) decreases gradually, causing the collector current of Q112 to decrease gradually. Therefore, the base current of Q103 decreases and it goes off gradually. Q103 turns off approximately 400 msec after Q509 is turned on.
- Once Q112 turns off, the base of Q103 is fixed at a negative voltage applied through R150 to lock it in the off state. Reproduce muting is completely released in this condition.

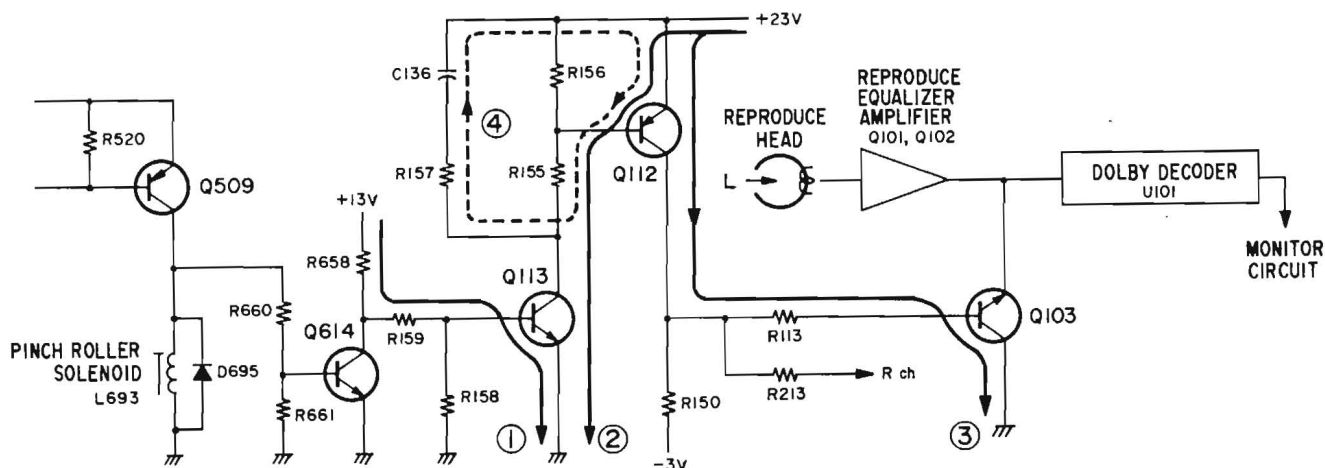


Fig. 3-24 Reproduce muting circuit

3-10-3 Record muting circuit

See Fig. 3-25.

Record inhibit switch S694 operates by mechanically detecting the presence or absence of a record protection tab on the cassette loaded in the deck.

S694 is in the N.O. position if the loaded cassette is protected by the tab being removed. In this case, pin 9 (AR IN) of system control IC U601 is fixed at L level. The deck will not enter the record/reproduce mode when the PLAY and RECORD buttons are depressed simultaneously if terminal AR is at L level. (The reproduce mode will be enabled in this case.)

S694 switches to N.C. when a recording-enabled cassette tape (i.e. protection tab not removed) is loaded. Now current from U601 charges capacitor C607 and terminal AR switches to H level. When terminal AR is at H level, recording can occur. Hereafter it is assumed that terminal AR is at H level.

1) Record/reproduce mode

When the deck is in the stop mode, the circuits shown in Fig. 3-25 are in the following conditions.

Pins 12 and 10 of U601: L level

Transistors: Q604, Q609, Q612, Q114, and Q115: off

Transistors: Q608, Q610, Q611, Q110, and Q111: on

Record muting Q116: on

Record muting flip-flop: reset

Bias oscillator U103: not oscillating

If the PLAY (▶) and RECORD buttons have been depressed simultaneously, H-level signals are output from pins 12 and 10 of U601. The reproduce mode signal output from pin 12 is mainly for the control of mechanical tape transport operations (see 3-9-1). The record mode signal output from pin 10 initiates the following operations.

- a. When an H-level signal is output from pin 10 of U601, base current flows through Q604 and it turns on. As Q604 is on, current flows through the RECORD LED and turns it on. At the same time, Q611 turns off as its base current is cut off.
- b. As Q611 is off, Q610 turns off as its base current is cut off. Similarly Q111 turns off, as its base current is cut off.
- c. As Q111 is off, discharge current from C135 flows through the loop consisting of C135, the emitter of Q110, the base of Q110, and C135. As the discharging of C135 proceeds, the discharging current (the

base current of Q110) decreases and Q110 turns off slowly.

- d. As Q110 turns off gradually, the base current of Q116 decreases gradually and it is turned off slowly. As a result, the record amplifier is smoothly released from muting.
- e. On the other hand, if an H-level signal is output from pin 10 of U601, base current flows through Q115 and it turns on. Therefore, base current is applied to Q114 turning it on.
- f. When Q114 has turned on, bias oscillator Q103 begins to oscillate, its output being delivered to the erase head. At the same time, it is added to the output signal (audio signal) from the record amplifier after its level has been adjusted by the bias adjust circuit and the resulting signal is supplied to the record head.

2) REC/MUTE mode

If you depress the REC MUTE button when the deck is in the record/reproduce mode, the recording signal is muted to leave a blank section on the tape.

When the deck is in the record/reproduce mode the circuits shown in Fig. 3-25 are as in the following condition.

Pins 12 and 10 of U601: H level

Transistors: Q604, Q608, Q114, and Q115: on

Transistors: Q609—Q612, Q110, Q111, and Q116: off

REC MUTE flip-flop: reset

Bias oscillator: oscillating

Record muting: released

If the REC MUTE button has been depressed in the record/reproduce mode, the circuits operate as described below to enable the REC/MUTE mode.

- a. When the REC/MUTE button has been depressed, the REC MUTE flip-flop is reset by an L-level signal. Q608 turns off as its base current is cut off.
- b. As Q608 is off, its collector rises to H level and base current flows through Q609 turning it on. When Q609 is on, its collector is at L level. Therefore, if the REC MUTE button is released and the L-level signal is removed from the REC MUTE flip-flop, Q608 stays off and Q609 on.
- c. As Q609 is on, base current flows through Q610, turning it on. When Q610 turns on, Q111, Q110, and Q116 turn on in sequence, as opposed to on in the record/reproduce mode, and the record amplifier

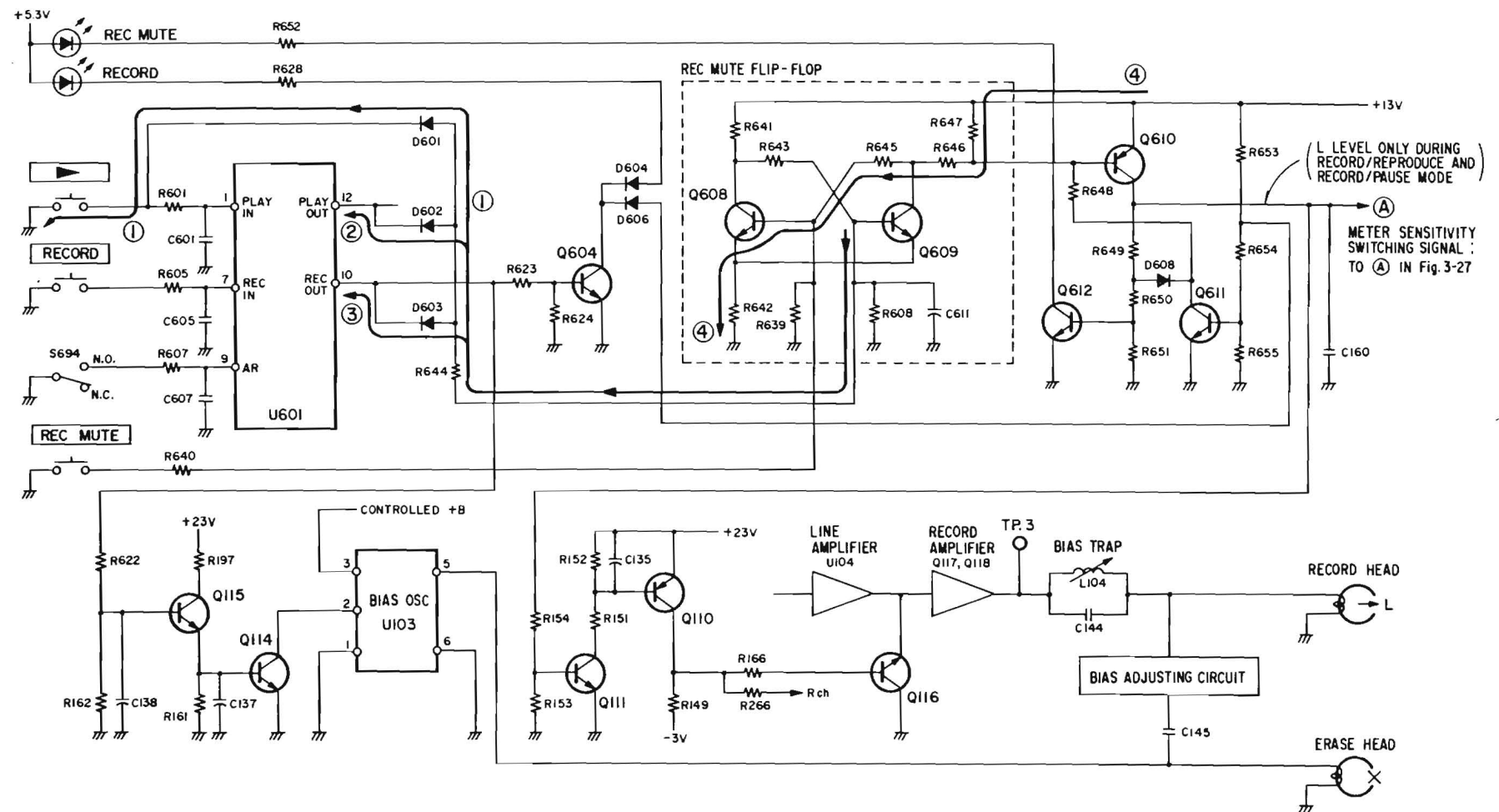


Fig. 3-25 Record muting circuit

is muted. Since the bias oscillator is working at this time, the tape runs with no signal recorded on it.

- d. On the other hand, when Q610 turns on, base current flows through Q612, turning it on (Q611 is off during record mode). When Q612 turns on, the REC MUTE LED lights.

The REC/MUTE mode is released by re-setting the REC MUTE flip-flop. There are three ways this can be done as below.

- i) Depress the PLAY button.
An L-level reset signal will be applied to the base of Q609 via path ①.

- ii) Depress the PAUSE button.
When the PAUSE button has been depressed, the deck changes from the record/reproduce (mute) mode to the record/pause mode. Therefore, pin 12 of U601 changes from H level to L, applying L level signal to the base of Q609 via path ②.

- iii) Depress any of the STOP, F.FWD, and REW buttons.

The record/reproduce (mute) mode will be released and pins 12 and 10 of U601 drop to L level. As a result, a reset signal will be applied to the base of Q609 via path ② or ③.

When an L-level reset signal has been applied to the base of Q609, Q609 turns off as its base current is cut off. Since the collector of Q609 rises to H level, base current flows through Q608 and it turns on resetting the REC MUTE flip-flop. When Q609 is off, Q610 turns off as its base current is cut off. (Note: In this case, the base current of Q608 flows via path ④). The voltage drop across R647 caused by this current (the emitter-base voltage of Q610) is approximately 0.16 V so Q610 cannot turn on.) When Q610 has turned off, Q111, Q110, and Q113 turn off in sequence to release the record amplifier from muting. Note that, when the STOP, F.FWD, or REW button is depressed during REC/MUTE mode (case (iii)), the record mode will be released. In this case, when pin 10 of U601 drops to L level, Q604 turns off as its base current is cut off, while Q611 turns on as base current is applied to it. Therefore, even if Q609 turns off with the REC MUTE flip-flop reset, Q610 remains on because its base current flows via R648 and Q611. This means that the record amplifier is not released from muting.

AMPLIFIER SECTION

3-11. REPRODUCE CIRCUIT

See Fig. 3-26.

- a. The signal picked up by the reproduce head is amplified by reproduce equalizer amplifier transistors Q101 and Q102. The reproduce equalizer amplifier negative feedback loop determines the compensation characteristic (time constants) for reproduction as given in Table 1. The compensation curve at high frequencies is determined by the composite resistance of R301–R304, the combination of which is determined by the settings of SPEED switches S4-10 and S4-8 and EQ switch S5-2, and the capacity of C104. Table 2 summarizes the composite resistances in relation to the settings of the SPEED and EQ switches.

Table 1
Compensation characteristic for reproduction

EQ \diagdown SPEED	STANDARD	HIGH
METAL	3180 + 70	3180 + 35
Co (CrO ₂)	3180 + 70	3180 + 35
NORMAL	3180 + 120	3180 + 50

(unit: μ sec)

Table 2 Composite resistance

EQ \diagdown SPEED	STANDARD	HIGH
METAL	R302 = 6.2k	R301//R302 \approx 3.1k
Co (CrO ₂)	R302 = 6.2k	R301//R302 \approx 3.1k
NORMAL	R302 + R304 \approx 10.9k	R301//R302 + R303//R304 \approx 4.2k

("//" represents parallel connection of resistors. unit: ohms)

- b. Capacitor C107 and coil L101 connected in series are a bias trap with a resonance frequency of 100 kHz.
- c. Semi-fixed resistor R11 adjusts reproduction level.
- d. Capacitor C108 and semi-fixed resistor R10 compensate for characteristics at high frequencies.
- e. Thermistor RT10 compensates for variations in the sensitivity of the reproduce head due to temperature changes.
The standard resistance of RT10 is 10k ohms at room temperature (25°C). The resistance decreases (increases) when the temperature rises (falls). On the other hand, the sensitivity of the reproduce head rises

(falls) when the temperature rises (falls). If the sensitivity of the reproduce head has risen due to a rise in temperature, for example, the output level of the reproduce equalizer amplifier increases. But the resistance of the thermistor drops at the same time and, therefore, the input level of Dolby decoder U101 drops. As a result, the input level of U101 remains constant and is independent of the temperature.

- f. In the Dolby decoder, L102 and C112 form a low-pass filter with a cutoff frequency of approximately 22.5 kHz. L103 and C113 form a band-elimination filter. These filters remove undesirable frequency components outside the audio range which might cause incorrect operation of the Dolby decoder.

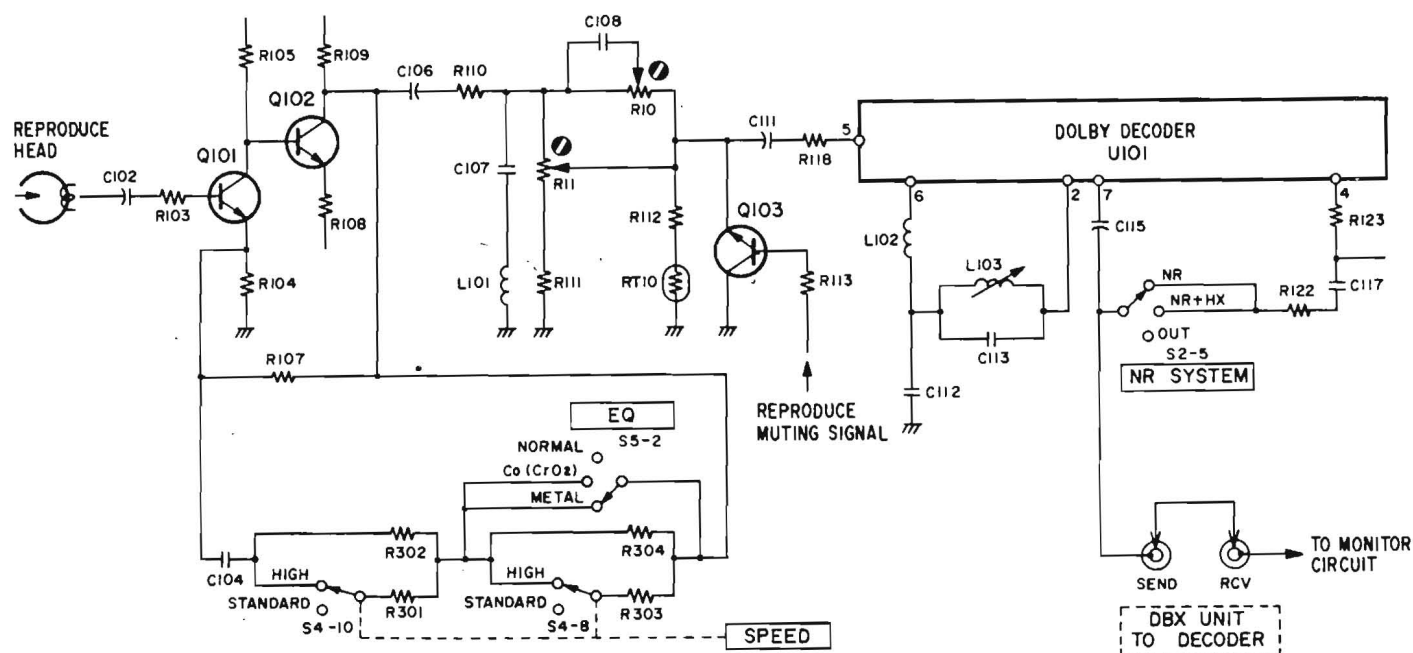


Fig. 3-26 Reproduce circuit

3-12. MONITOR CIRCUIT

See Fig. 3-27.

The tape reproduce signal or source signal selected by MONITOR switch S2-5 is distributed to

three lines: the output circuit, phone amplifier, and meter amplifier. The output of the meter amplifier is sent to the VU meter circuit and peak indicator circuit.

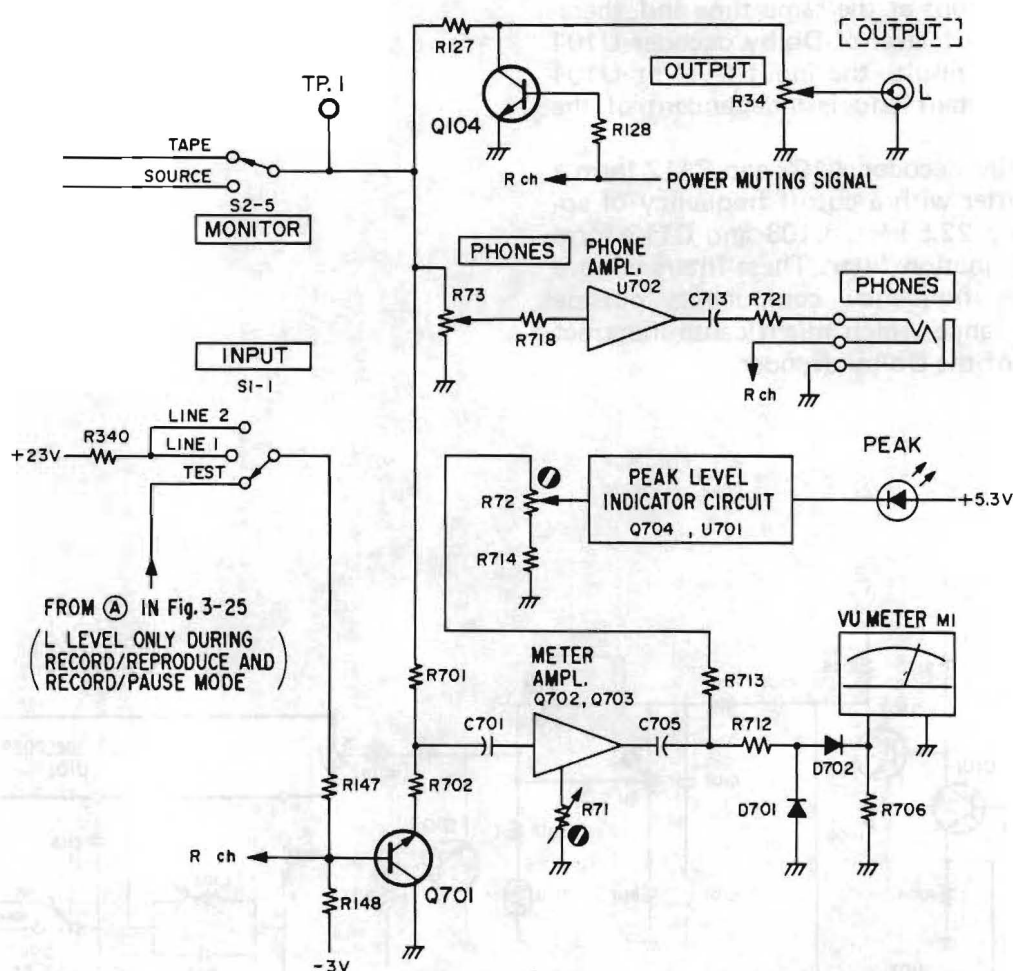


Fig. 3-27 Monitor circuit

3-12-1 Output circuit

The monitor signal selected by the MONITOR switch is output to the OUTPUT terminal via resistor R127 and OUTPUT control R34.

The rated output level at the OUTPUT terminal is -7 dB when the level at TP1 is 580 mV (Dolby level). At this time the VU meter reads +3 VU.

3-12-2 Phone amplifier

The deck is provided with PHONES control R73. This allows the headphone monitor level to be varied independently of the VU meter reading and the output level at the OUTPUT terminal. The maximum output of the phone amplifier is 100 mW into an 8-ohm load.

3-12-3 Meter circuit

1) Meter sensitivity switching circuit

The bias and equalization of the deck are adjusted for suitability with different types of tape. In addition, the deck is provided with a BIAS/REC calibration circuit that allows bias to be adjusted to the most suitable value for the individual tape used to optimize tape performance. When adjusting bias and recording level using this circuit the signal input level at the LINE 1 terminal is -30 dB, which is 20 dB lower than the rated input level of -10 dB. This low level would not normally be read by the VU meter, so a circuit which increases meter sensitivity during adjustment is provided.

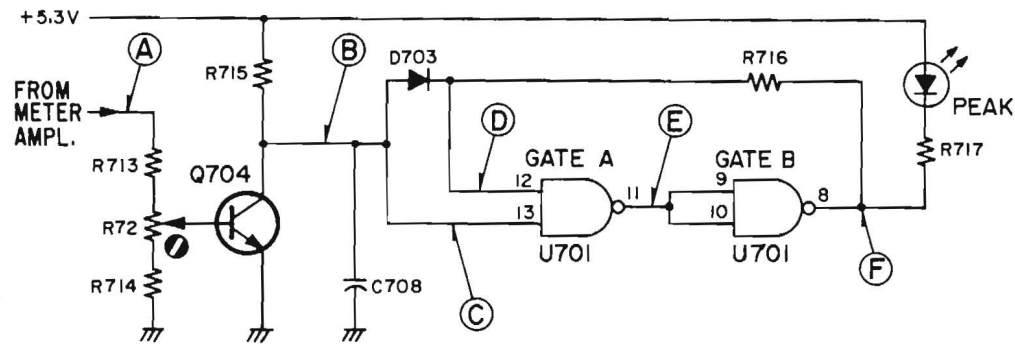


Fig. 3-28 Peak indicator circuit

When INPUT switch S1-1 is set to LINE 1 or LINE 2, base current flows through Q701 and it is on. As Q701 is on, resistor R702 is inserted in parallel to the input circuit of the meter amplifier. This setting provides the standard meter sensitivity.

When the INPUT switch is set to TEST and the deck is in the record/reproduce or record/pause mode, Q701 is off as its base current is cut off. When Q701 is off, R702 is disconnected from the input circuit of the meter amplifier. As a result, the signal input level of the meter amplifier rises by about 20 dB. This rise in the input level results in a rise of the output level by the same amount so that meter sensitivity is raised by 20 dB.

2) Peak indicator circuit

See Fig. 3-28 and 3-29.

Semi-fixed resistor R72 determines the operating level of the peak indicator.

When the signal level supplied from the meter amplifier is lower than the threshold level of Q704 determined by R72, the condition of the circuit shown in Fig. 3-28 is as follows.

Q704: off

C708: charged

Pins 12 and 13 of U701: H level

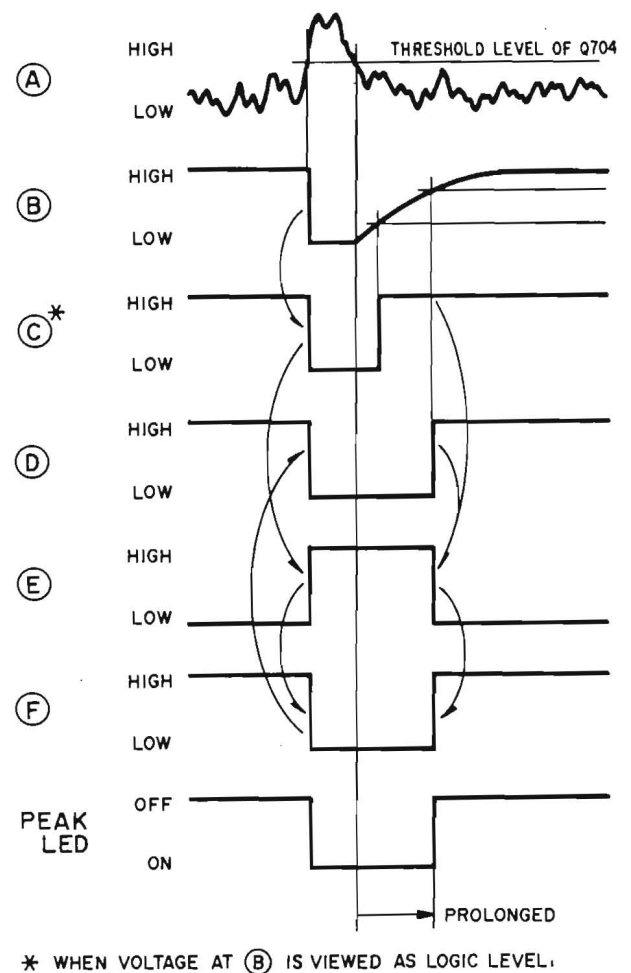
Pins 11, 9, and 10 of U701: L level

Pin 8 of U701: H level

Peak indicator: off

When a high-level, pulse-like signal is output from the meter amplifier, the circuit operates as follows.

- a. When the input signal level exceeds the threshold level of Q704 determined by R72, base current flows to Q704 and it turns on.



* WHEN VOLTAGE AT (B) IS VIEWED AS LOGIC LEVEL.

Fig. 3-29 Peak indicator circuit timing diagram

- b. When Q704 turns on, its collector drops to L level and C708 discharges momentarily. Therefore, pin 13 of U701 drops to L level. This inverts gate A, causing a H level at pin 11 of U701. After inversion by gate B, an L level occurs at pin 8 of U701.
- c. When pin 8 of U701 has dropped to L level, current flows through the PEAK LED and the peak indicator lights.
- d. Alternately, the L level at pin 8 of U701 is transmitted to pin 12 of U701 via resistor R716. If R716 is open, pin 12 of U701 would not fall to L level when the collector of Q704 has dropped to L level because of the presence of diode D703. In this case, operation would not be stable.
- e. When the input level falls below the threshold level of Q704, its base current stops, turning it off.
- f. When Q704 has turned off, current flows into C708 via R715 to charge it. The voltage across C708 (the voltage at ⑥) rises as shown in Fig. 3-29.
- g. When the voltage at ⑥ has risen to a certain level (E1: approx. +2.0 V), U701 regards the input at pin 13 as H level. Waveform ③ represents the voltage at ⑥ as logic level.
- h. When the charging of C708 proceeds and the voltage at ⑥ reaches E2 which is approximately 0.6 V higher than E1 (forward voltage drop of D703), U701 regards the input at pin 12 as H level. At this moment, gate A is inverted since pins 12 and 13 of U701 are both H level, and the output from pin 11 of U701 drops to L level.
- i. Therefore, gate B is also inverted and the output of U701 pin 8 turns to H level. As a result, current supplied to the PEAK LED is cut off and the peak indicator goes out.

As described above, the peak indicator circuit incorporates a pulse stretching function that keeps the peak indicator lit for a certain length of time even when the duration of the input signal is very short.

3-13. RECORD CIRCUITS

3-13-1 Line input circuits

See Fig. 3-30.

The deck has two line input circuits. LINE 1 is provided at the back of the deck and LINE 2 on the front panel. The INPUT switch determines which line input is used. Signals from the LINE 1 and LINE 2 input terminals cannot be mixed. To use the BIAS/REC calibration circuit, set the INPUT switch at TEST and apply input signals to the LINE 1 terminals.

With its level adjusted by the RECORD volume control, the line input signal selected by the INPUT switch is sent to Dolby encoder U301.

MPX filter U305 connected to U301 removes subcarrier and pilot signals which are mixed with line input signals when recording FM broadcasts in order to prevent the Dolby encoder from mis-operation. The MPX filter operates only when transistors Q301 and Q302 are both on. When they are off, the signals simply pass through the filter. Q301 and Q302 are on only when the NR SYSTEM switch is set to NR or NR+HX: that is, when U301 is operating as an encoder.

Whatever the position of the NR SYSTEM switch, an unmodified input signal is output from pin 3 of U301 to the monitor circuit.

When the NR SYSTEM switch is set to NR or NR+HX, an encoded signal is output from pin 7 of U301. When the switch is at OUT, an unmodified input signal is output. The output from pin 7 is input to the line amplifier via the HX variable equalizer. (Refer to 3-14 for the HX variable equalizer.)

3-13-2 Line amplifier

See Fig. 3-31.

Recording level adjusting circuit BIAS/REC CALIBRATION is included in the input circuit of the line amplifier. When the CALIBRATION switch is set at ADJUST, the recording level can be adjusted with semi-fixed resistor R30. At this time ADJUST LED D1 lights.

A temperature compensation circuit comprising thermistor RT11 is located in parallel with the output line of the line amplifier.

The output of the line amplifier is sent to the recording level adjusting circuit after the record signal level has been adjusted to match the type of tape being used.

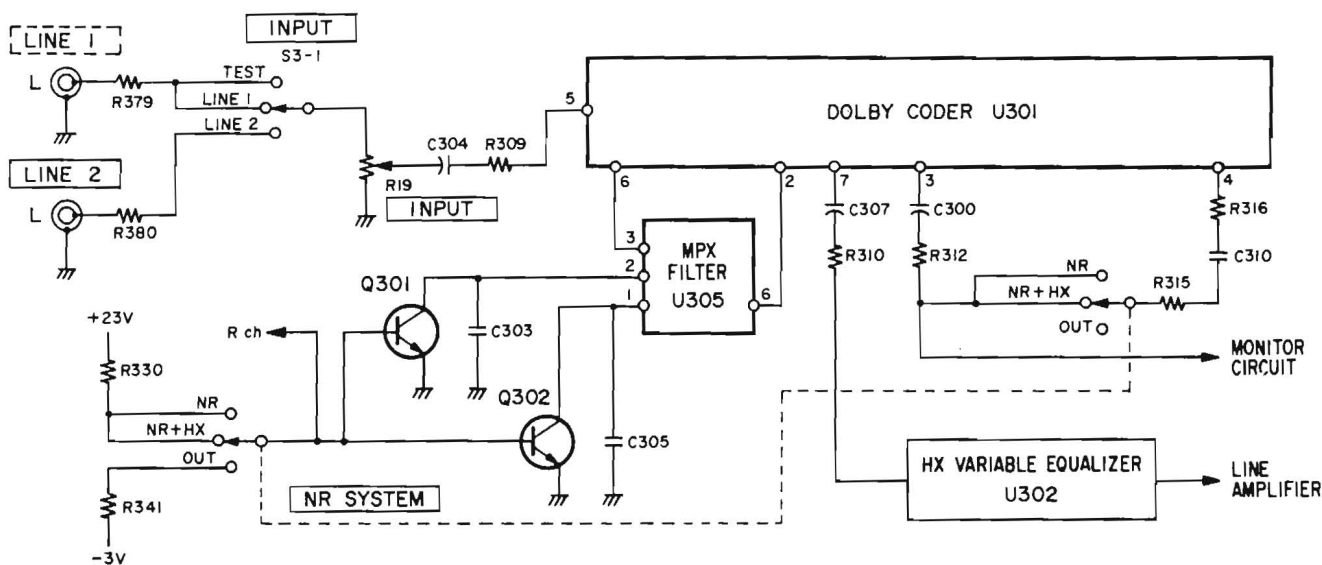


Fig. 3-30 Line input circuit

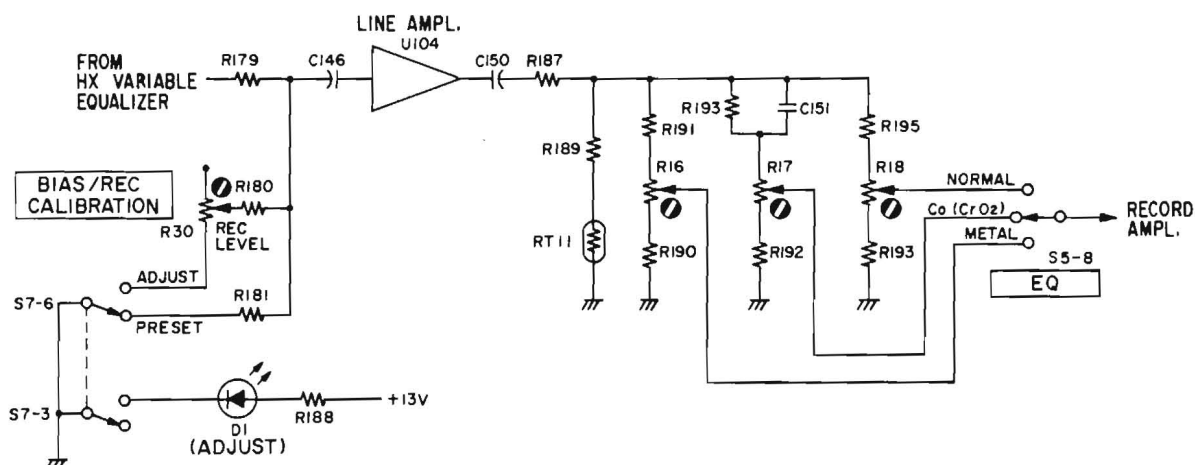


Fig. 3-31 Line amplifier

3-13-3 Record amplifier

See Fig. 3-32.

The output of the line amplifier is sent to the record amplifier comprising transistors Q117 and Q118. The record amplifier adjusts the recording signal depending on the speed and type of tape. The recording equalization characteristics are determined by the LC resonance circuit and CR circuit connected to the emitter of Q117. Because of this, a complementary circuitry consisting of NPN (Q117) and PNP (Q118) transistors is used in the record amplifier for more efficient operation requiring less voltage.

Resistor R176 raises the output impedance (impedance of the signal source viewed from the record head) of the record amplifier to drive the record head with constant current.

The parallel resonance circuit of L104 and C144 is a bias trap with a resonance frequency of 100

kHz. At the resonance frequency, the impedance of the resonance circuit becomes infinitely large, preventing bias current from entering the record amplifier (if this should happen, the amplifier would be saturated and the signal distorted). The record signal output from the record amplifier passes through the bias trap and, after the addition of bias current, drives the record head. Bias current is supplied by bias oscillator U103. When the BIAS/REC CALIBRATION switch S7-2 is set to PRESET, the record head is supplied with bias current adjusted by R13, R14, or R15 according to the setting of BIAS switch S6-2 for the type of tape being used. When S7-2 is at ADJUST, bias can be adjusted by turning semi-fixed resistor R35 which is accessible from the front of the deck. The supply voltage of the bias oscillator is controlled by the Dolby HX circuit. The circuit that controls the supply voltage is described in 3-14.

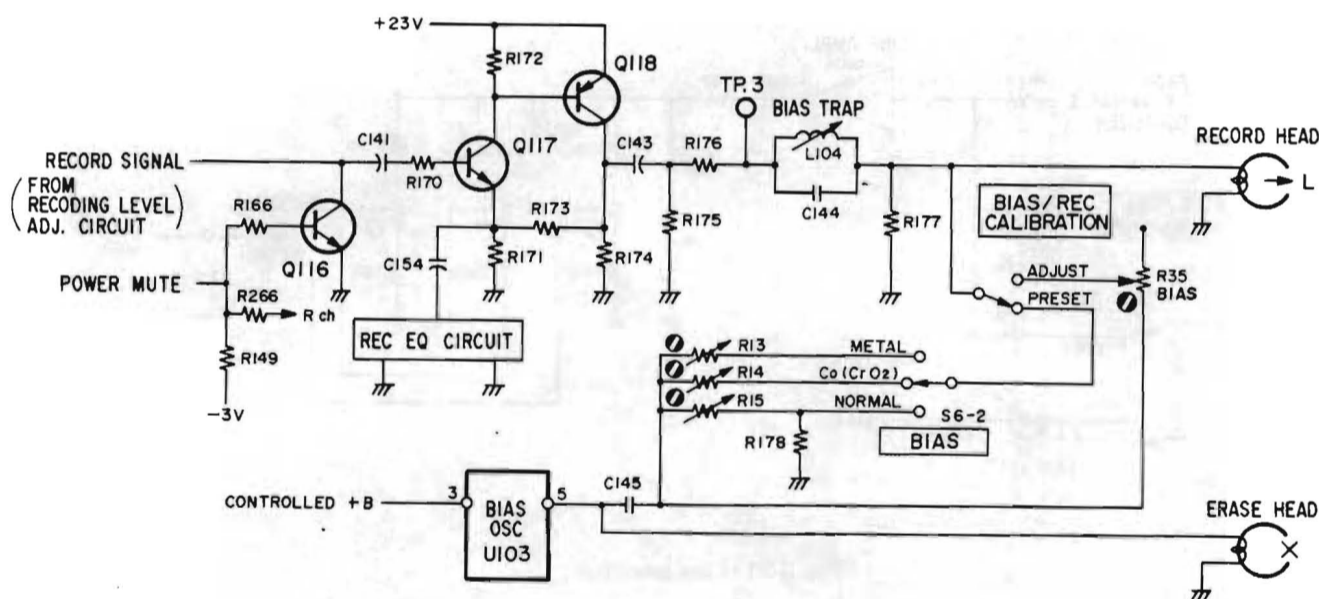


Fig. 3-32 Record amplifier

3-14. DOLBY HX CIRCUIT

NOTE: The Dolby Headroom Extension system (Dolby HX system) is provided in the record circuit of the deck and operates only in the following conditions.

NR SYSTEM switch: NR + HX

SPEED switch: STANDARD

BIAS switch: Co (CrO₂) or NORMAL

EQ switch: Co (CrO₂) or NORMAL

Mode: record/reproduce mode

3-14-1 Bias characteristics

Generally tape has the bias characteristic as shown in Fig. 3-33. In the bias characteristic, (relationship of bias current to record/reproduce level) of a record signal of 315 Hz, for example, the record/reproduce output level rises with bias current and it reaches maximum at the maximum sensitivity bias current (peak bias). If bias current increases further the record/reproduce output level falls gradually. On the other hand, distortion is diminished as bias current increases. The variation of output level with bias current follows a relatively gentle curve at low frequencies but is steep at high frequencies. The output level at peak bias falls as the frequency becomes higher.

For tape having specific bias characteristics, major factors determining bias current are sensitivity, distortion, and frequency response.

Normally bias is determined in the following way. In the frequency spectrum of music signals which are most commonly recorded low and middle frequency components dominate and the spectrum drops steeply at high frequencies. Conventionally bias was determined by taking mainly sensitivity and the distortion of bass and mid-range components into consideration, sacrificing frequency response at high frequencies.

However, for maximum sensitivity at bass and mid-range frequencies, bias should be much higher than at high frequencies. Therefore, strong equalization is required for recording high frequencies. (Fig. 3-33 and 3-34 show recording equalization for 10 kHz at peak bias of 315 kHz.) When equalization during recording is too great, tape tends to be saturated by high-frequency components when the recording level is high or when the signals include many high-frequency components. This results in an increase in distortion and a degradation of frequency response (see Fig. 3-35). When bias is too low, the recording magnetic field becomes wider and, therefore, demagnetization increases at high frequencies. This phenomenon becomes

more noticeable with higher signal levels. Therefore, demagnetization causes the frequency response at high frequencies to diminish as the recording level increases.

From the above facts, we determined that bias must be relatively small in order to improve frequency response at high frequencies, especially for high-level, high-frequency signals.

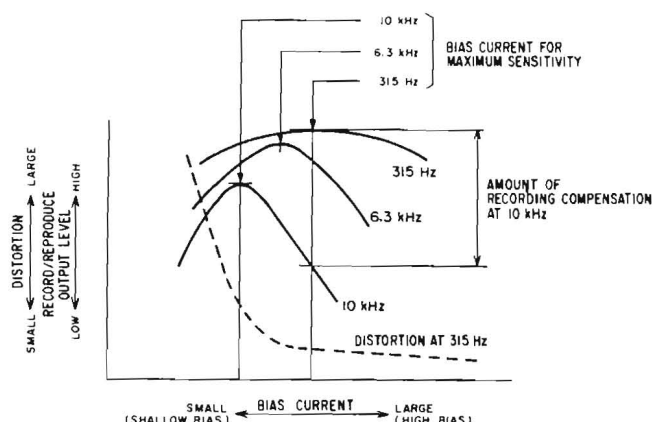


Fig. 3-33 Tape bias characteristics (1)

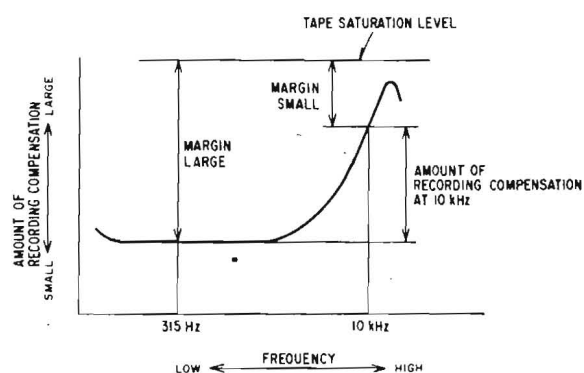


Fig. 3-34 Recording compensation characteristics (1)

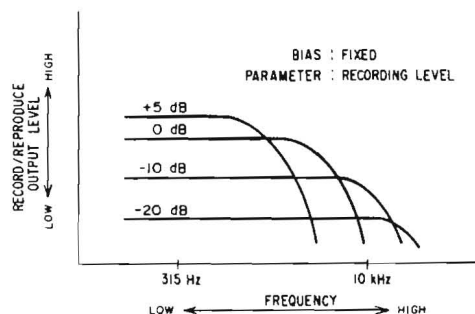


Fig. 3-35 Recording frequency response (1)

3-14-2 System outline

To improve the frequency response at high frequencies, especially for high-level, high-frequency signals, the Dolby HX system automatically controls bias and recording equalization for optimum levels with respect to the level of recording input signal and the relative amount of high-frequency components.

1) Bias

- When bass and mid-range components dominate in the input signal or the overall level of the input signal is low, a fixed high bias is applied. (See ① in Fig. 3-36.) In this case, frequency response at low frequencies can be improved by selecting a bias more suitable for lower frequency content than the conventional fixed bias.
- When the input signal involves high-level, high-frequency components, bias is decreased instantly depending on the frequency components and level, increasing the sensitivity at high frequencies. (See ② in Fig. 3-36.)

2) Record equalizer

The Dolby HX system not only controls bias as described above but also recording equalization. This is because tape sensitivity varies at high frequencies, accompanying the change in bias.

- When bass and mid-range components dominate the input signal and bias is selected as ① in Fig. 3-36, tape sensitivity is low at high frequencies and, therefore, the recording equalization is that of curve ① shown in Fig. 3-37. With curve ①, the amount of boost at high frequencies is very large but the level of high-frequency components of the input signal is low. Therefore, distortion will not occur during recording.
- With high-level, high-frequency signals, bias is lowered. (See ② in Fig. 3-36.) With lower bias, tape sensitivity increases at high frequencies and the amount of recording equalization may be reduced, as shown by curve ② in Fig. 3-37.

Reduction in the amount of recording equalization, i.e. boost, results in expanding the headroom of the tape saturation level of high-frequency signals. (This is the origin of the name of Dolby Headroom Extension system.) As a result, frequency response at high frequencies is greatly improved (see Fig. 3-38.) and at the same time, distortion at high frequencies is minimized.

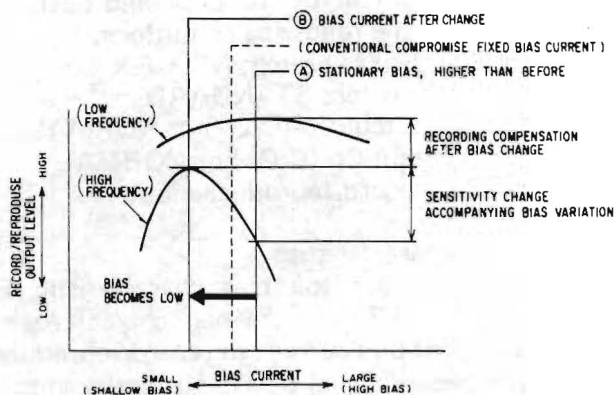


Fig. 3-36 Tape bias characteristic (2)

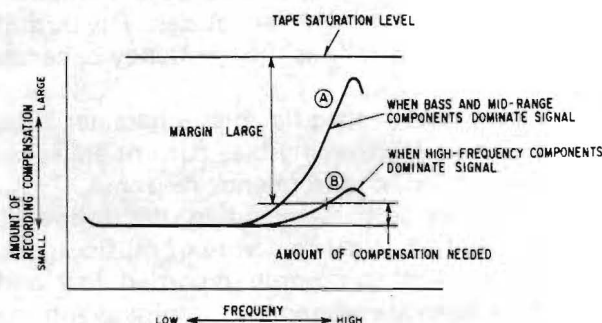


Fig. 3-37 Recording equalization characteristic (2)

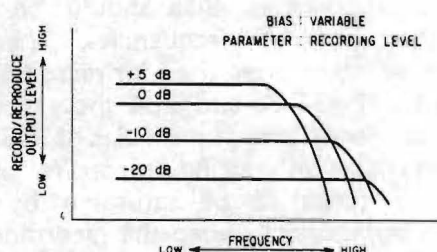


Fig. 3-38 Recording frequency response (2)

3-14-3 Circuits

See Fig. 3-39.

There are three circuits that control the recording bias and equalization characteristics, depending on the spectrum of the input signal. These are the control signal circuit, the variable bias circuit, and the variable equalizer.

1) Control signal circuit

The recording bias and equalization characteristics must be varied in accordance with high-frequency components of the input signal and their level. For this purpose, it is necessary to generate a signal which controls them, which is done by detecting and measuring high-frequency components in the input signal and their level.

In the Dolby B-type processor (as used in the M122), the noise reduction control signal is generated from the same parameters as those used by the Dolby HX system. This signal is taken from pin 14 of Dolby NR IC U301 (U401) and supplied to buffer amplifiers U303-a and U303-b.

- a. U303-a and U303-b select and output the higher of the two input signals without permitting the Dolby processors of the left and right channels to interfere with each other.
- b. The output of the buffer stage is applied to pin 12 of high-gain, non-inverting amplifier U303-c. Generally the DC output voltage of this amplifier rises together with the DC input voltage. A DC bias voltage adjusted by semi-fixed resistor R36 or R37 is applied to pin 13 of U303-c. This voltage determines the threshold of the control voltage where the recording bias begins to decrease due to high-frequency components contained in the recording input signal. The threshold varies with the type of tape; R36 adjusts for 'normal' tape while R37 adjusts for 'Co (CrO₂)' tape.
- c. The output of DC amplifier U303-c is sent to the selector circuit which generates conditions for Dolby HX system operation. The output of U303-c is fed to the variable bias circuit and variable equalizer circuit only in the following conditions.

NR SYSTEM switch: NR+HX

SPEED switch: STANDARD

BIAS switch: Co (CrO₂) or NORMAL

2) Variable bias circuit

The output of the selector circuit is applied to pin 2 of U303-d.

- a. U303-d is an inverting amplifier with a gain of 1 using $V_{cc}/2$ as its reference voltage. The DC output voltage falls (rises) as the DC input voltage rises (falls).

The output of U303-d controls the base voltage of transistor Q303 which is located in series with the power supply circuit of bias oscillator U103.

- b. When the level of high-frequency components contained in the recording signal is high, the DC voltage applied to pin 2 of U303-d by the control signal circuit rises and, therefore, the DC output voltage from pin 1 of U303-d falls. When the voltage at pin 1 of U303-d falls, the base voltage of Q303 falls and its base current decreases. As a result, the collector current of Q303 decreases, the voltage drop across the collector and emitter increases, and the voltage supplied to bias oscillator U103 falls. When the supply voltage to U103 falls, the output of the oscillator falls, that is, bias is lowered. The minimum and fixed (maximum) bias levels are determined by R328 and R329.

3) Variable equalizer

The output of the control signal circuit is supplied to the variable bias circuit and the variable equalizer simultaneously.

- a. The variable equalizer is basically a low-pass filter. A pair of variable conductance amplifiers U302s are used to provide variable cutoff time constant T_c , which is a linear function of the current flowing through resistor R335.
- b. When the level of high-frequency components in the recording signal is high, the DC output voltage of the control signal circuit rises and current flowing through R335 increases. As a result, variable cutoff time constant T_c becomes large and the turnover frequency falls.
- c. Since the variable equalizer is basically a low-pass filter, reduction in turnover frequency results in increased attenuation at high frequencies. Because of this, the recording signal passing through the variable equalizer varies as curves ① and ② shown in Fig. 3-37.

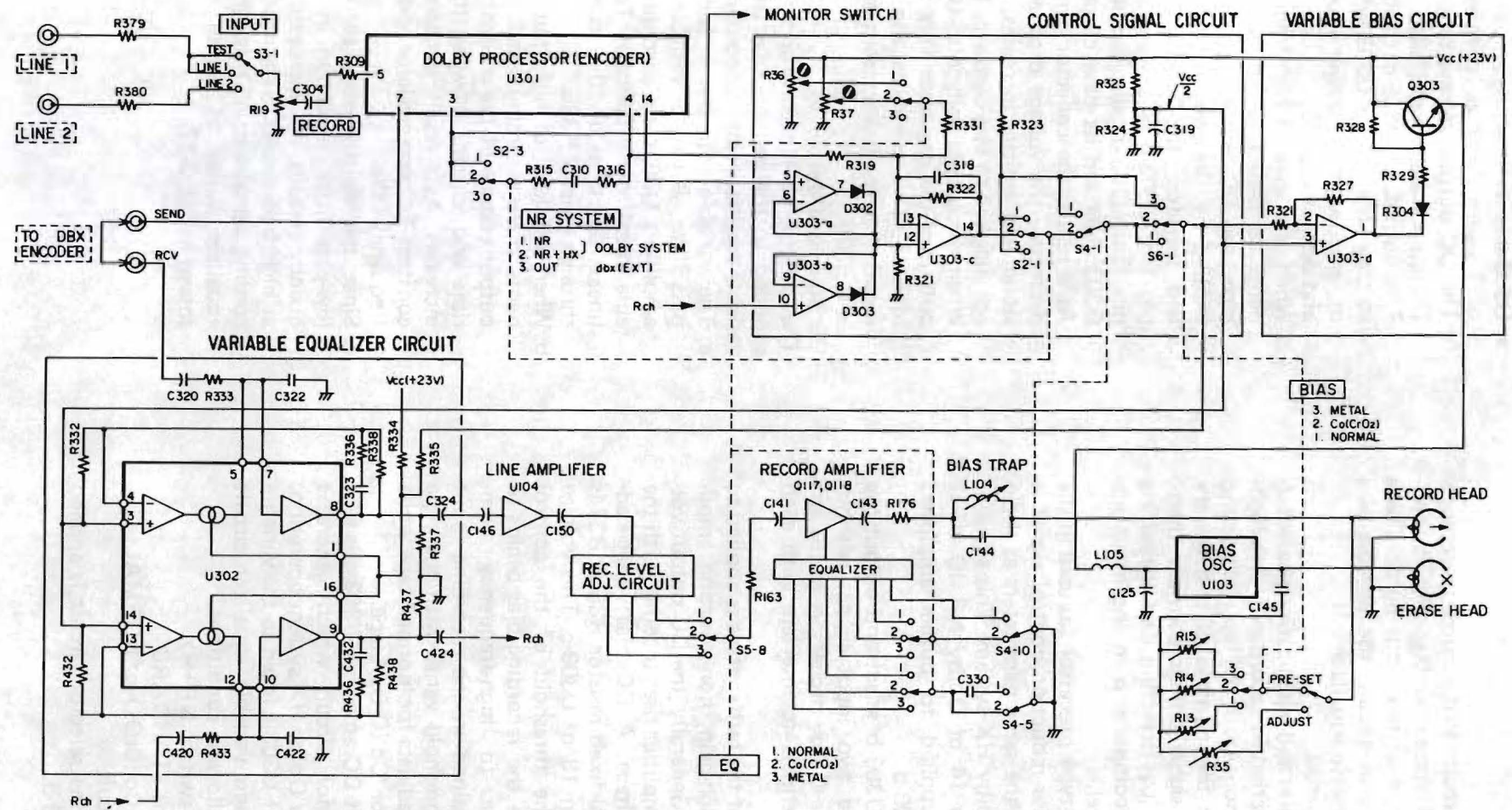
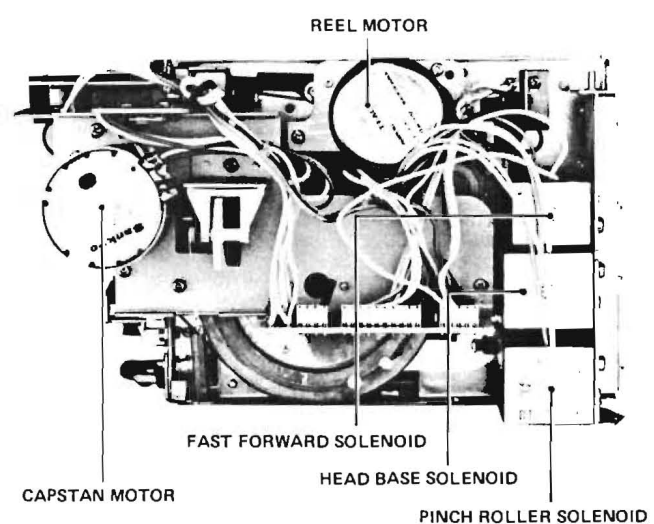
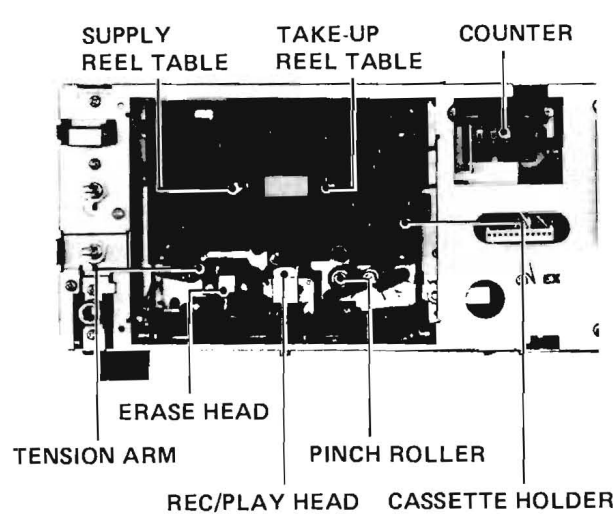
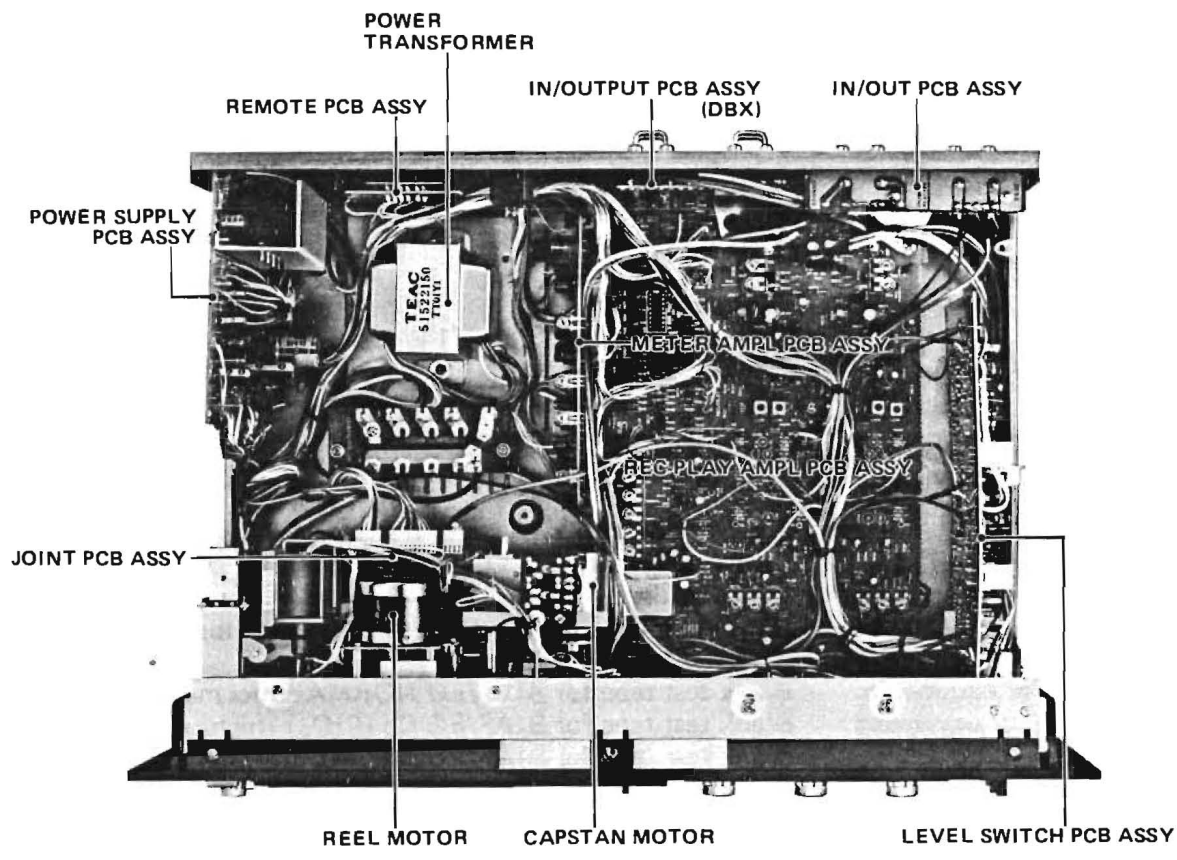


Fig. 3-39 Dolby HX system

4. PARTS LOCATION



5. ESSENTIAL MAINTENANCE EQUIPMENT/MATERIAL

Spring scale:	For pinch roller pressure check, 0 to 1 kg (2.2 lbs)
Cassette torque meter:	For torque check, 0 to 100 g-cm (0 to 1.4 oz-inch), 0 to 160 g-cm (0 to 2.2 oz-inch)
Wow & flutter meter:	Meguro Dempa Sokki Model MK-668B or equivalent
Audio oscillator:	Hewlett Packard Model 204C or equivalent
Frequency counter:	Range: 0 to 1 MHz, Sensitivity: 0.1 V RMS, Impedance: More than 1 M Ω , less than 25 pF
Level meter:	Range: -80 to +40 dB Impedance: More than 1 M Ω , less than 25 pF
Band pass filter:	1 kHz narrow band pass type
Distortion meter:	Basic frequency 400 Hz, 1 kHz
Oscilloscope:	Ordinary type
Attenuator:	Ordinary type
Test load resistor:	Noninductive type 8 ohm/1 W
Head demagnetizer:	TEAC E-3
Bulk tape eraser:	TEAC E-2A or equivalent
Cleaner:	TEAC recorder cleaner kit or pure alcohol
Oil:	TEAC oil kit or equivalent
Test tapes:	
TEAC MTT-111:	Wow & flutter or tape speed test tape, 3000 Hz/- 10 dB
TEAC MTT-150:	Dolby level calibration test tape, Dolby B-type tone (400 Hz), 200 nWb/m
TEAC MTT-316:	Head azimuth/frequency characteristic test tape for EQ Co (CrO ₂), 3180 μ s + 70 μ s
TEAC MTT-501 or equivalent:	Blank test tape for BIAS/EQ NORMAL (normal-bias tape)
TEAC MTT-5061 or equivalent:	Blank test tape for BIAS/EQ Co (CrO ₂) (high-bias tape)
TEAC MTT-5072:	Blank test tape for BIAS/EQ METAL

6. ELECTRO-MECHANICAL CHECKS AND ADJUSTMENTS

6-1. HEAD BASE PLATE POSITIONING

- 1) Set the deck in the PLAY mode.
- 2) Push the head base plate by hand in the direction of the arrow and check that the head base plate and the stopper portion of the mechanism chassis make contact.
- 3) If there is any clearance, loosen the two screws on the head base plate solenoid and reposition the solenoid until the clearance is eliminated.

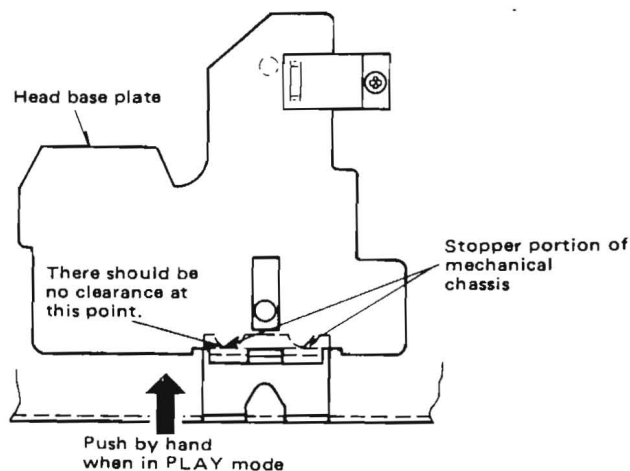


Fig. 6-1

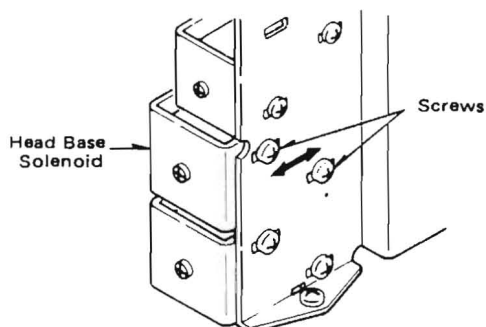


Fig. 6-2 Head base solenoid location

6-2. MICROSWITCH (A) ASSEMBLY CLEARANCE

- 1) Insert a blank cassette and close the cassette holder.
- 2) Loosen the two screws on the microswitch (A).
- 3) Move the switch so that actuator of the switch contacts the safety lever.
- 4) Adjust the switch position to obtain a clearance of between 0.1 mm to 0.3 mm.
- 5) Retighten the screws.

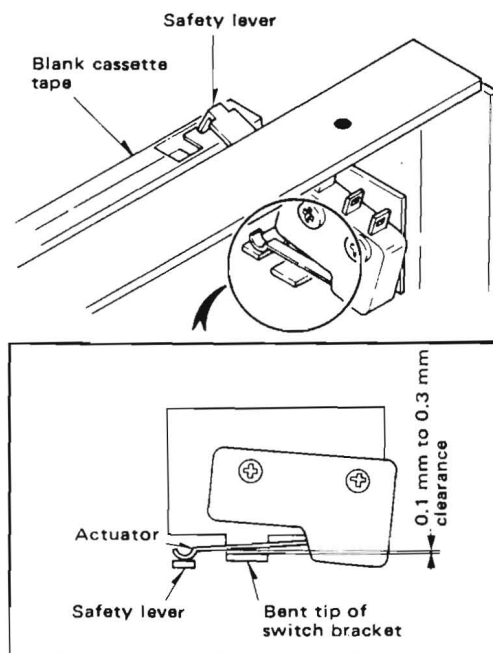


Fig. 6-3

6-3. MICROSWITCH (B) ASSEMBLY CLEARANCE

- 1) Push the EJECT button to open the cassette holder.
- 2) Loosen the two screws on the microswitch (B).
- 3) Move the switch so that switch actuator contacts the bent projecting portion of the eject lever.
- 4) Adjust the switch position to obtain a clearance of approximately 1 mm.
- 5) Retighten the screws.

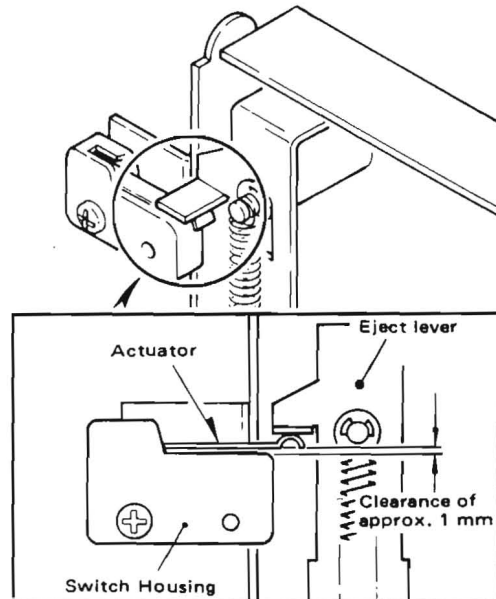


Fig. 6-4

6-4. CAPSTAN ASSEMBLY THRUST

- 1) Turn the thrust adjusting screw so that thrust of the capstan shaft is within 0.05 mm to 0.15 mm.

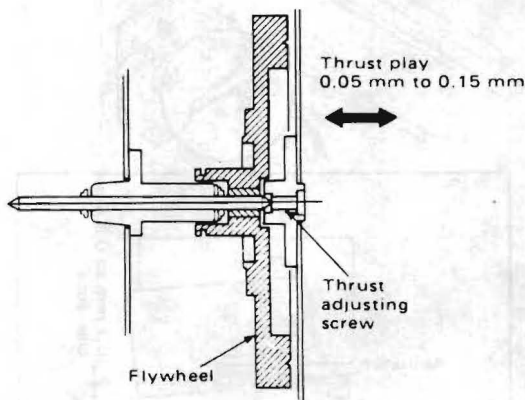


Fig. 6-5

6-5. TAKEUP TORQUE

Takeup torque adjustment is critical to stabilize tape travel and reduce variations in tape speed.

- 1) Load a cassette torque meter (0 to 100 g-cm, 1.4 oz-inch) in the cassette holder.
- 2) Measure the torque by running the tape of the meter in the reproduce mode. The meter reading should be 45 – 65 g-cm (0.6 – 0.9 oz-inch).
- 3) If the reading is outside this range, clean the surface of the idler pulley in the reel table assembly which comes into contact with the tape using cleaning liquid. Also check the operation of the moving parts of the reel table assembly.
- 4) If the reading is still unsatisfactory, replace the reel table ass'y.

6-6. FAST FORWARD AND REWIND TORQUE

- 1) Load a cassette torque meter (0 to 160 g-cm, 2.2 oz-inch).
- 2) With the deck in the fast forward and rewind modes, read the meter. If the meter is provided with tape, note the readings with the tape fully wound on the reel taking up the tape in each mode so that the measurement is not influenced by the tape's inertia. The fast forward torque must be in the range 90 – 160 g-cm (1.3 – 2.2 oz-inch) and the rewind torque must be in the range 90 – 160 g-cm (1.3 – 2.2 oz-inch).
- 3) If the readings are outside these ranges, clean the surface of the idler pulley with cleaning liquid and check the operation of the moving parts of the reel table ass'y.

6-7. PINCH ROLLER PRESSURE

Pinch roller pressure must also be adjusted to the correct value to stabilize tape travel and reduce variation in tape speed.

- 1) Remove the cassette door cover to install the torque scale.
- 2) With the deck in the reproduce mode, attach the scale near the shaft of the pinch roller, being careful not to touch the pinch roller. See Fig. 6-6.
- 3) Move the scale gradually in the direction of the arrow until the capstan shaft and pinch roller are completely separated.
- 4) Gradually return the pinch roller and note the reading on the scale when the pinch roller touches the capstan and starts rotating. The reading should be between 390 and 490 g (13.8 and 17.3 oz).
- 5) If the reading is outside this range, replace the pinch roller pressure spring or adjust the pressure by bending the spring as shown in Fig. 6-6.

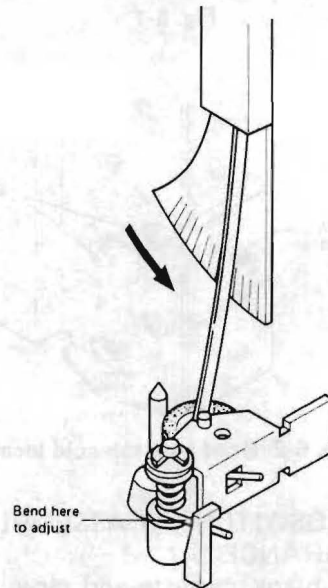


Fig. 6-6

6-8. TAPE SPEED

Use the TEAC MTT-111 test tape (containing highly accurate 3-kHz signals) or its equivalent to measure tape speed.

- 1) Connect a frequency counter to the OUTPUT terminals as shown in Fig. 6-8.
- 2) Play the test tape from the start of the tape and check that the frequency counter reading is within 3 kHz ± 0.5 %.
- 3) If the reading is outside this range, clean the tape path and check the pinch roller pressure and takeup tension.
- 4) If these values are correct, adjust the resistor of the motor so that the reading is within the range 3000 Hz ± 5 Hz.

NOTE: Adjust tape speed after the tape has run for about 30 sec in the reproduce mode.

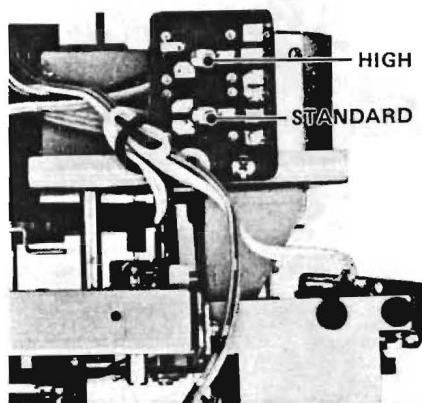


Fig. 6-7

- 2) Set the flutter meter controls to the required standard. Select the DIN/IEC/ANSI peak value or the NAB RMS value, then set the weighting control as required.

- 3) Measure at the beginning and the end of the tape. The measured value will differ slightly according to the measuring method and instrument used. Standard values are:

1-7/8 ips:

- ± 0.085 % peak (DIN/IEC/ANSI weighted)
- ± 0.18 % peak (DIN/IEC/ANSI unweighted)
- 0.06 % (NAB weighted)
- 0.11 % (NAB unweighted)

3-3/4 ips:

- ± 0.055 % peak (DIN/IEC/ANSI weighted)
- ± 0.13 % peak (DIN/IEC/ANSI unweighted)
- 0.04 % (NAB weighted)
- 0.07 % (NAB unweighted)

NOTE: Measure after cleaning the tape path, especially the capstan shaft, pinch roller and head surfaces.

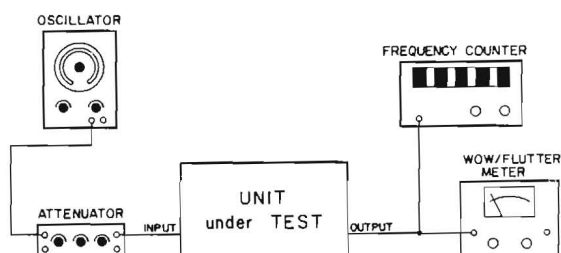


Fig. 6-8

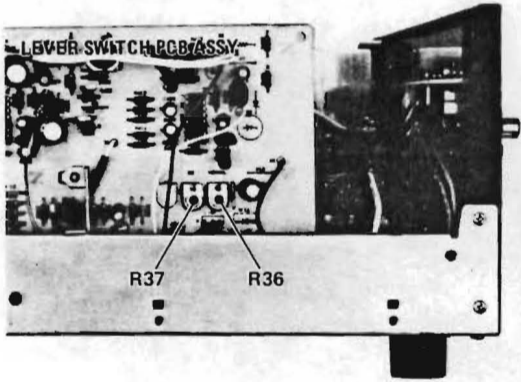
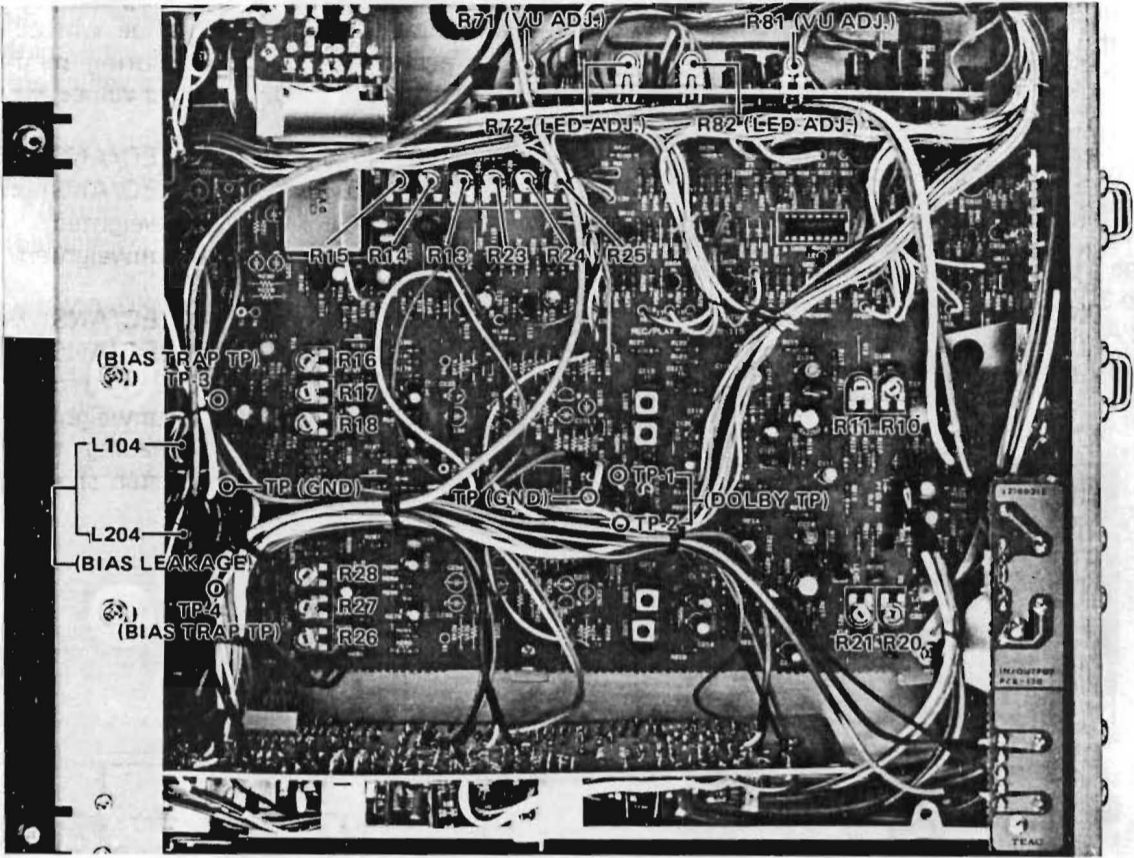
6-9. WOW AND FLUTTER

Before measuring wow and flutter, the following points should be read carefully. It is necessary to decide which of the two measurement methods should be used.

- 1) **Reproduce method:** Measure while playing wow & flutter test tape MT-111 or its equivalent.

Record/reproduce method: Record a 3-kHz signal on blank tape, rewind the tape and reproduce the recorded signal.

NOTE: When measuring using the record/reproduce method, the recorded section should be reproduced repeatedly to obtain the mean value. Be careful not to read the meter for those parts of the tape in which wow & flutter components in recording and reproducing cancel each other.



7. RECORD/REPRODUCE AMPLIFIER CHECKS AND ADJUSTMENTS

Remove the top cover by unscrewing the screws securing it. When the top cover is removed, the record/reproduce amplifier PCB ASSY can be seen. When adjusting the azimuth of the record/reproduce head, remove the cassette holder door cover.

The following points should be observed before starting the record/reproduce amplifier checks or adjustments.

- * Before adjusting the amplifier, the erase head, record/reproduce head and tape path should be demagnetized and cleaned with cleaning fluid.
- * Adjust the left channel first, then the right channel. In the circuit diagrams, 100-series numbers refer to left channel components and 200-series numbers refer to right channel components. For example, R180 is a left channel resistor while R280 is the equivalent right channel resistor.

Left channel/Right channel components are shown as R180/R280.

- * 0 dB = 1 V

- * Unless otherwise specified, set the switches as follows:

Switches	Positions
MONITOR	TAPE
DOLBY NR	OUT
INPUT	LINE 1 or 2
SPEED	STANDARD
EQ	METAL
BIAS	METAL
MEMORY	OFF
CAL	PRESET

- * If characteristics such as frequency response and crosstalk are found to be unsatisfactory, it is necessary to check and adjust the azimuth of the record/reproduce head first prior to performing amplifier adjustment.

Record/reproduce head azimuth check and adjustment

Connect an oscilloscope and a VTVM to the OUTPUT terminals as shown in Fig. 7-1. Play test tape MTT-150 to check that the phase difference between the L and R channels is less than 45°.

Reproduce the 10-kHz/-10 dB signal from test tape MTT-316 and turn the azimuth adjusting nut to maximize the levels of both channels.

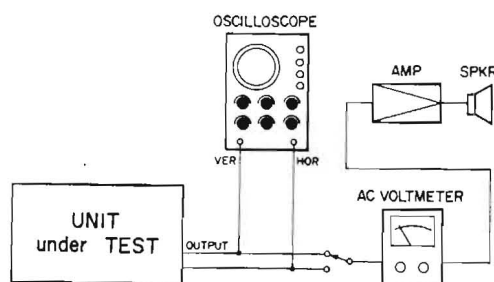


Fig. 7-1

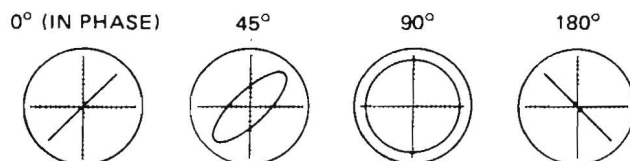


Fig. 7-2

7-1. REPRODUCE OUTPUT LEVEL SETTING

- 1) Load test tape MTT-150 and play it.
- 2) Connect the HOT terminal of the VTVM to DOLBY T.P. (TP.1/TP.2) and the COLD terminal of the VTVM to TP (GND) and check that the DOLBY T.P. voltage is 580 mV (-2.5 dB).
- 3) If this value cannot be obtained, adjust semi-fixed resistors R11/R21.
- 4) Also connect the VTVM to the OUTPUT terminal and confirm that the OUTPUT level is -4.5 dBV \pm 2 dB when the OUTPUT level control is maximum.

7-2. VU METER SETTING

- 1) Load test tape MTT-150 and play it.
- 2) Check that the VU meter reading is +3 VU \pm 1 VU.
- 3) If the VU meter reading is not correct, adjust semi-fixed resistors R71/R81.

7-3. REPRODUCE FREQUENCY RESPONSE

- 1) Connect a VTVM to the OUTPUT terminal.
- 2) Play test tape MTT-316 and check the output level. Confirm that the level at 10 kHz is within \pm 2 dB of the level at 315 Hz.
- 3) If the response is unsatisfactory, adjust semi-fixed resistors R10/R20. If the result is still unsatisfactory, check the tape travel and head azimuth.
- 4) Play the 10-kHz signal from the test tape and change the EQ switch setting to NORMAL. Confirm that the output level is about 4.5 dB \pm 1 dB higher than with the switch in the METAL position.

7-4. BIAS SETTING ADJUSTMENT

Before adjusting the bias setting:

- Connect the measuring instruments as shown in Fig. 7-3.
- Load a blank tape and put the deck in the record/pause mode.
- Apply a -14 dBV/400 Hz signal to the LINE 1 or 2 terminal.
- Adjust the INPUT (LEFT/RIGHT) level control until the VU meter reads 0 VU.
- Adjust the OUTPUT level control so that the OUTPUT terminal level is -10 dBV.

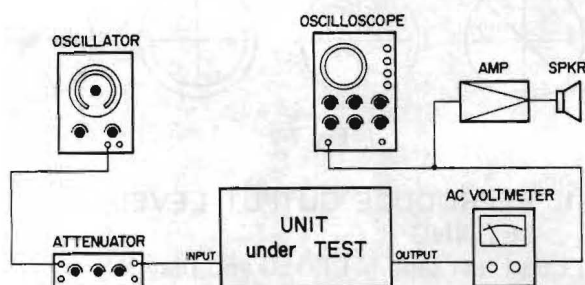


Fig. 7-3

Bias setting at position METAL

- Set the EQ and BIAS switches to METAL.
- Alternately record -44 dBV signals at 400 Hz then 10 kHz on blank tape (MTT-5072) and reproduce them.

NOTE: The level -44 dBV is 30 dB lower than the standard level.

- Note readings of the OUTPUT level at the OUTPUT terminal and check that the output levels are identical for both frequencies.

- If the result is unsatisfactory, adjust semi-fixed resistors R15/R25.

NOTE: Turning the semi-fixed resistors clockwise increases bias current and decreases high frequency response; turning them counterclockwise increases high frequency response.

Bias settings at NORMAL and Co (CrO₂) positions

This is done in the same way as for the metal bias setting. Refer to the following table:

Positions	EQ/BIAS switches	Blank tape	Adjusting points
BIAS METAL	METAL	MTT-5072	R15/R25
BIAS Co(CrO ₂)	Co(CrO ₂)	MTT-5061	R14/R24
BIAS NORMAL	NORMAL	MTT-501	R13/R23

7-5. RECORD LEVEL

Adjust this after the setting of the reproduce and bias levels (7-1 and 7-4) and VU meter (7-2) is complete.

The following items 1) — 5) indicate the standards levels and setting orders of each control.

METAL

- Connect the measuring instruments as shown in Fig. 7-3.
- Set the BIAS and EQ switches to METAL and the MONITOR switch to SOURCE.
- Load blank tape (MTT-5072) and set the deck in the record/pause mode.
- Apply -14 dBV/400 Hz signals to LINE 1 or 2.
- Adjust the INPUT (LEFT/RIGHT) level control until the VU meter reads 0 VU. Adjust the OUTPUT level control so that the OUTPUT terminal level is set to -10 dBV.
- Set the MONITOR switch to TAPE. Record and play the blank tape to check that the OUTPUT level is -10 dBV \pm 1 dB.
- If satisfactory values are not obtained, adjust semi-fixed resistors R16/R26.

Co(CrO₂) and NORMAL

This is done in the same way for metal tape.

Perform adjustment referring to the following table.

Positions	EQ/BIAS switches	Blank tapes	Adjusting points
METAL	METAL	MTT-5072	R16/R26
Co(CrO ₂)	Co(CrO ₂)	MTT-5061	R17/R27
NORMAL	NORMAL	MTT-501	R18/R28

7-6. OVERALL FREQUENCY RESPONSE

METAL

Obtain the standard setting according to procedures 1) — 6) of 7-5. and check the record/reproduce signals.

- Obtain -44 dBV by decreasing the input signal level by 30 dB and record and play it on blank tape (MTT-5072).

Change the input signal level and confirm that the level at 12 kHz is within \pm 2 dB of the level at 400 Hz. Also confirm at high tape speed.

If the response is unsatisfactory, check whether the record/reproduce head is dirty or set correctly. It is also necessary to check the bias level setting.

NOTE: Perform this adjustment with the NR SYSTEM switch set OUT.

Co(CrO₂) and NORMAL

Take the same procedures as for metal tape. Refer to Table under paragraph 7-5 for the tapes to be used and the switch settings.

7.7. OVERALL SIGNAL-TO-NOISE RATIO

Obtain the standard setting according to procedures 1) – 6) of 7-5. to check record/reproduce level.

- 1) Recording input signal of -14 dBV/400 Hz on a blank tape for a short time. Then mute the signal and record with no input signal.
- 2) Rewind the tape to the start of the recorded section.
- 3) Play back the recorded section and measure the output level of the section with the signal, then, at the point where the signal stops, increase the sensitivity of the VTVM and measure the output level of the no-signal section. The output level measurement should be weighted.
- 4) Calculate the level ratio of noise with respect to the recorded signal and confirm that they are identical to the values shown in the table below.

For the tapes to be used and the switch settings, refer to Table under paragraph 7-5.

If the values are unsatisfactory, proceed as follows:

- * Demagnetize and clean the erase and record/reproduce heads.
- * Check that erasing is being done effectively.
- * Check and adjust reproduce and record/reproduce frequency response.
- * Check and adjust the bias trap.
- * Replace the tape.

SPEED	STANDARD	HIGH
METAL Co(CrO ₂)	More than 48 dB	More than 49 dB
NORMAL	More than 45 dB	More than 46 dB

7-8. OVERALL DISTORTION

- 1) Connect the measuring instruments as shown in Fig. 7-4. Obtain the standard setting according to procedures 2) – 6) of 7-5. and check record/reproduce level.
- 2) Record an input signal of -14 dBV/400 Hz on blank tape and play it back to measure the distortion of the output signal.

- 3) The value should be less than 1.0 % for any of the tapes used.

For the tapes to be used and the switch settings, refer to Table under paragraph 7-5.

If satisfactory values are not obtained, check the bias setting again, also check the S/N ratio and the overall frequency response.

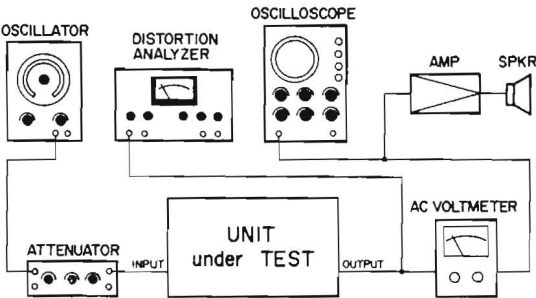


Fig. 7-4

7-9. ERASURE

- 1) Connect the measuring instruments as shown in Fig. 7-5. To check that erasing is effective, use a 1-kHz bandpass filter.
 - 2) Obtain the standard setting according to procedures 2) – 5) of 7-5.
 - 3) With a -4 dBV/1 kHz (saturation level) signal, increase the input signal level by 10 dB and record it on blank tape. Reproduce this to measure the OUTPUT terminal level decreasing the sensitivity of the VTVM by about 10 dB.
 - 4) Rewind the tape to the start of the recording. Erase the recorded section with no input signal.
 - 5) Play back the erased section and measure the output level, increasing the sensitivity of the VTVM.
 - 6) Calculate the ratio of the signal output level to the output level obtained by playing the erased tape.
 - 7) The value should be more than 65 dB for any of the tapes to be used.
- For the tapes to be used and the switch settings, refer to Table under paragraph 7-5.
- If the erase effect is unsatisfactory, check whether the erase head is clean and the tape is running correctly.

NOTE: When checking erasure, make sure the blank tape used has been erased by a bulk eraser before using it. Correctly tune the frequency of the signal to be recorded to match the bandpass filter and compensate for measuring instrument loss.

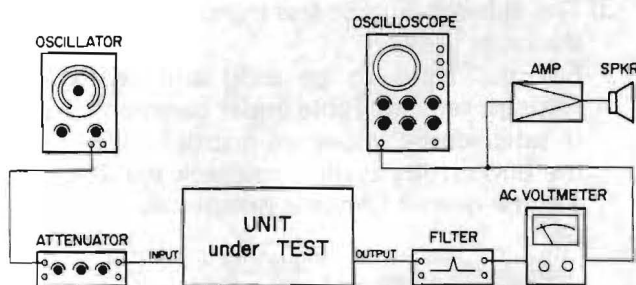


Fig. 7-5

7-10. CHANNEL SEPARATION

- 1) Connect the measuring instruments as shown in Fig. 7-5.
For the right channel, connect only the VTVM. For the left channel, install a 1-kHz bandpass filter between the OUTPUT terminal and the VTVM.
- 2) With a 1-kHz input signal, obtain the standard setting according to procedures 2) – 6) of 7-5. to check the record/reproduce level.
- 3) Make a stereo recording applying the input signal only to the left channel and no signal to the right channel.
- 4) Rewind the tape to the start of the recording and play it.
Measure the output levels of both channels. (The right channel will contain the recorded signal and the left channel will contain components which have leaked from the right channel.).
- 5) Calculate the difference in level between the two channels. This value should be more than 35 dB.

7-11. LED LIGHTING OF VU METER (PEAK indicator)

- According to procedures 1) – 5) of 7-5., adjust until the VU meter indicates 0 VU.
- 1) Confirm that the LED lights when the input level is increased by 8 dB from -14 dBV and does not light when the input level is increased by 7 dB from -14 dBV.
 - 2) If the lighting level is not satisfactory, adjust semi-fixed resistors R72/R82.

7-12. DOLBY NOISE REDUCTION EFFECT

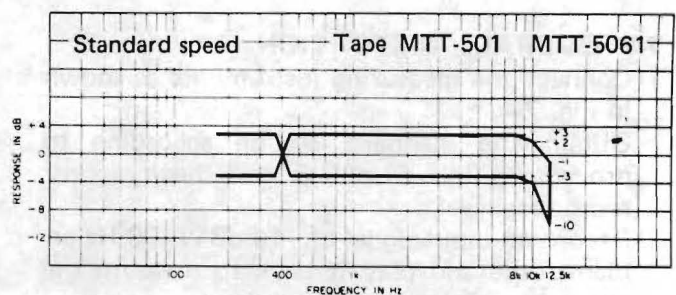
- 1) Connect the measuring instruments as shown in Fig. 7-3.
- 2) Set the EQ and BIAS switches to match the blank tape used and the MONITOR switch to SOURCE.

- 3) Load the blank tape and put the deck in the record/pause mode.
- 4) Apply a -14 dBV/1 kHz signal to the LINE 1 or 2 terminal.
- 5) Adjust the INPUT (LEFT/RIGHT) level control so that the VU meter indicates +3 VU. Also adjust the OUTPUT level control so that the OUTPUT terminal level is -7 dBV.
- 6) Set the MONITOR switch to TAPE. Record a -37 dBV/1 kHz signal on the blank tape, decreasing the input level by 23 dB and reproduce the signal.
- 7) While recording and reproducing, switch the NR SYSTEM switch between NR and OUT to check that the change in level is between 3 and 8 dB.
- 8) Check the level when a -47 dBV/10 kHz signal is recorded and reproduced. The values are shown in the following table.
Measure the OUTPUT terminal level, increasing the sensitivity of the VTVM by an amount equivalent to the decrease in the input signal level.

Input signal	Change in Output level
-37 dBV, 1 kHz	between 3 and 8 dB
-47 dBV, 10 kHz	between 8 and 12 dB

7-13. DOLBY HX EFFECT

- Follow the same procedures as in 7-12. DOLBY NR EFFECT up to item 3).
- 1) Apply a -14 dBV/400 Hz signal to the LINE 1 or 2 terminal.
 - 2) Adjust the INPUT (LEFT/RIGHT) level control so that the VU meter indicates 0 VU. Also adjust the OUTPUT level control so that the OUTPUT terminal level is -10 dBV.
 - 3) Set the NR SYSTEM switch to HX and check the response, changing the input signal frequency.



- 4) If the response decreases at high frequencies, adjust semi-fixed resistor R36 for NORMAL tape and R37 for Co (CrO₂) tape.

7-14. HEADPHONES OUTPUT LEVEL

- 1) Connect an 8-ohm load and a VTVM to the PHONES jack.
- 2) Load test tape MTT-150 and play it back to measure the headphones output level.
- 3) The value should be 0 dBV \pm 2 dB (100 mW) when the PHONES knob is set to maximum.

7-15. BIAS TRAP ADJUSTMENT

Bias trap adjustment is only necessary when:

- * the record/reproduce head is replaced,
- * parts in the record amplifier circuit (especially the bias oscillator and trap coil) are replaced,
- * too much bias leakage is observed.

- 1) Set the deck to the record/pause mode.
- 2) Connect the VTVM or oscilloscope's HOT terminal to T.P.3/T.P.4 (junction point between L104/L204 and R176/R276 of the bias trap) and its COLD terminal to TP (GND).
- 3) Adjust L104/L204 so that the level (bias leakage) reading is minimum.

NOTE: After adjusting the bias trap, check the bias setting, record level and overall frequency response.

7-16. BIAS/REC CALIBRATION CHECK

Prior to this check, set the deck as follows. The tape to be used for calibration is Co (CrO₂) MTT-5061.

- a. Set the EQ and BIAS switches to Co (CrO₂).
- b. Set the INPUT switch to TEST.
- c. Set the ADJUST/PRESET switch to ADJUST.
- d. BIAS/REC CALIBRATION:

BIAS L/R (R35/R45)
fully counterclockwise
REC LEVEL L/R (R30/R40)
fully clockwise

- 1) Set the deck to the RECORD/PAUSE mode and the MONITOR switch to SOURCE.
- 2) Apply a -34 dBV/1 kHz signal to LINE 1, and adjust the INPUT (LEFT/RIGHT) level control so that the VU meter indicates 0 VU. (When observed at the OUTPUT terminal, adjust the OUTPUT level control so that the level is -30 dBV.)

Variable BIAS CAL. range

- 3) Record and play back a 1 kHz input signal, setting the MONITOR switch to TAPE.

- 4) While recording and reproducing the signal, turn the BIAS L/R (R35/R45) clockwise to obtain the maximum value (L_{max}) of the VU meter. (When observed at the OUTPUT terminal, obtain the maximum level.)

- 5) Also obtain the indication value (L₁) of the VU meter when the BIAS L/R (R35/R45) is turned fully clockwise. (When observed at the OUTPUT terminal, obtain the OUTPUT level at that time.)

- 6) Confirm that the variable range is $L_{max} - L_1 \geq 4$ VU (or 4 dB at the OUTPUT terminal).

Variable REC CAL. range

- 7) As in the variable BIAS CAL. range, record and reproduce a 1 kHz signal, setting the MONITOR switch to TAPE.

- 8) While recording and reproducing this signal, turn the BIAS L/R (R35/R45) clockwise to obtain the maximum indication value (L_{max}) of the VU meter (when observed at the OUTPUT terminal, obtain the maximum level value.).

- 9) Obtain indication value L₂ of the VU meter when REC LEVEL L/R (R30/R40) is turned fully counterclockwise. (Obtain the OUTPUT level when observed at the OUTPUT terminal.).

- 10) Confirm that the variable range is $L_{max} - L_2 \geq 10$ VU (or 10 dB at the OUTPUT terminal).

BIAS/REC CALIBRATION setting

- 1) Set the deck to the RECORD/PAUSE mode and the MONITOR switch to SOURCE.

- 2) Apply a -34 dB/400 Hz signal to LINE 1. Adjust the INPUT (LEFT/RIGHT) level control so that the VU meter indicates 0 VU. (When observed at the OUTPUT terminal, adjust the OUTPUT level control to obtain -30 dBV.)

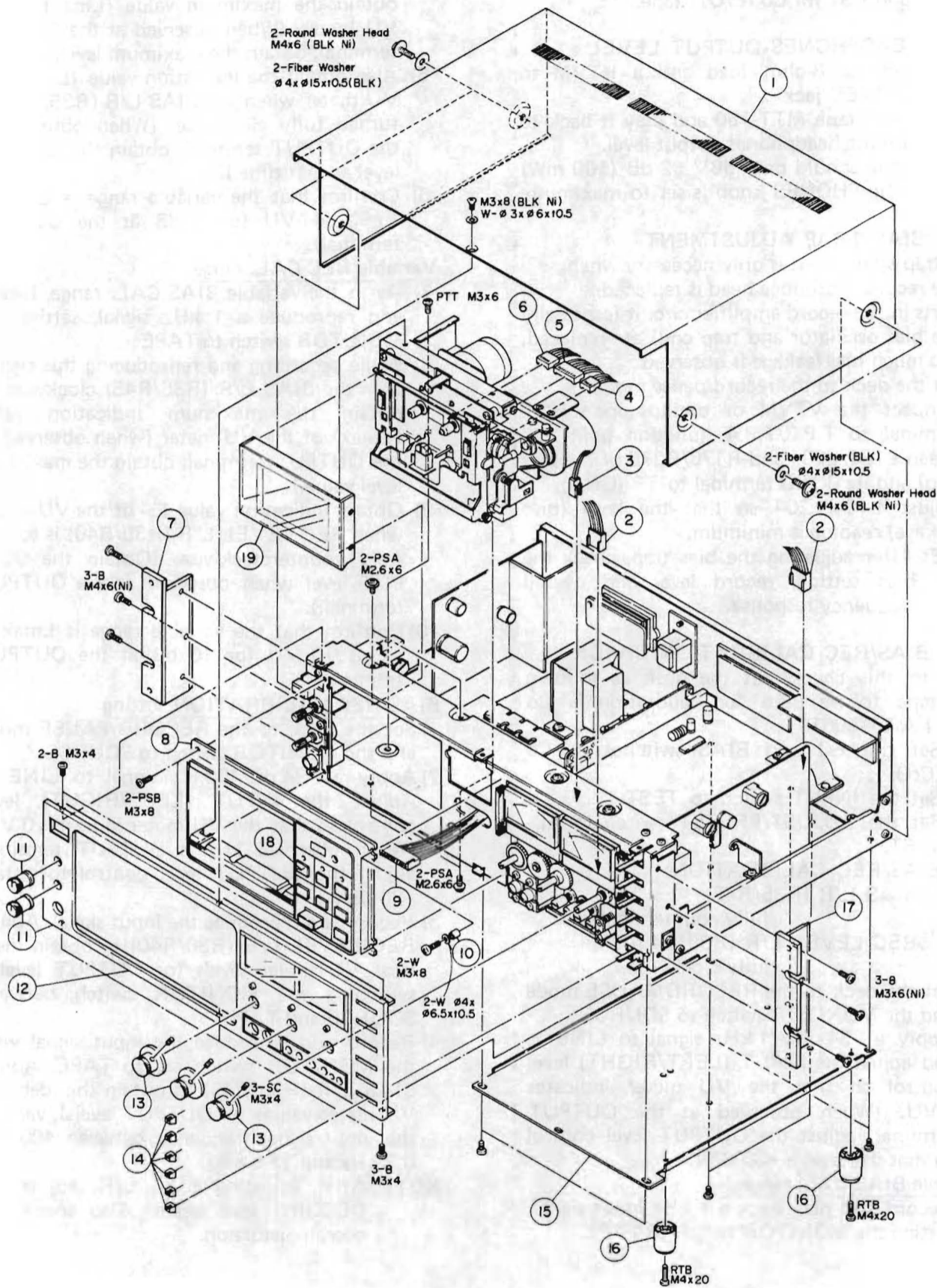
- 3) Record and reproduce the input signal. Adjust REC LEVEL L/R (R30/R40) to obtain identical VU meter levels (or OUTPUT levels), switching the MONITOR switch between SOURCE and TAPE.

- 4) Record and reproduce the input signal with the MONITOR switch set to TAPE. Adjust BIAS L/R (R35/R45) to obtain the identical VU meter values (or OUTPUT levels), varying the input signal frequency between 400 Hz, 6.3 kHz and 12.5 kHz.

NOTE: After adjusting BIAS L/R, adjust the RECORD level again. Also check the overall distortion.

8. EXPLODED VIEWS AND PARTS LISTS

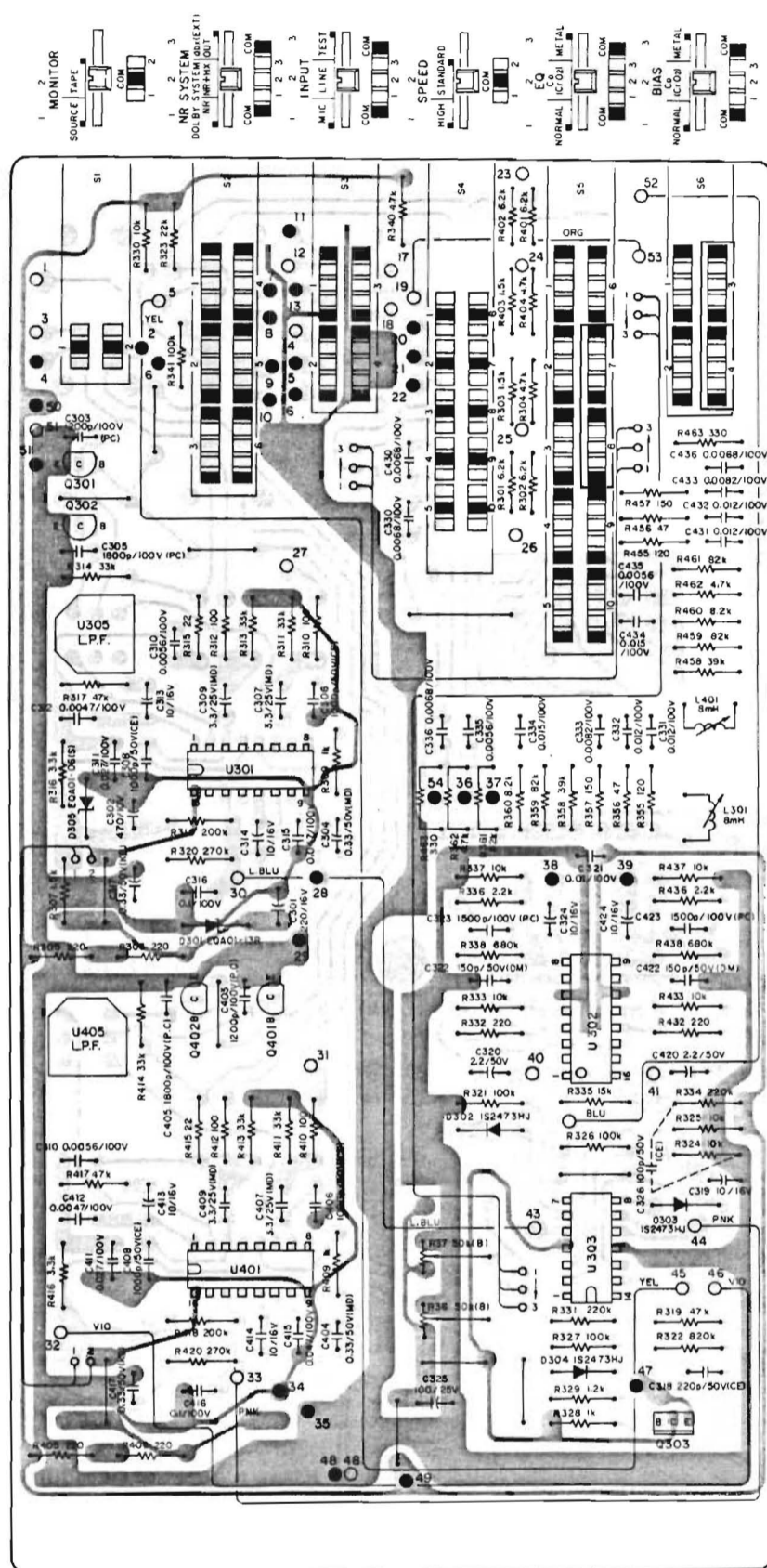
EXPLODED VIEW-1



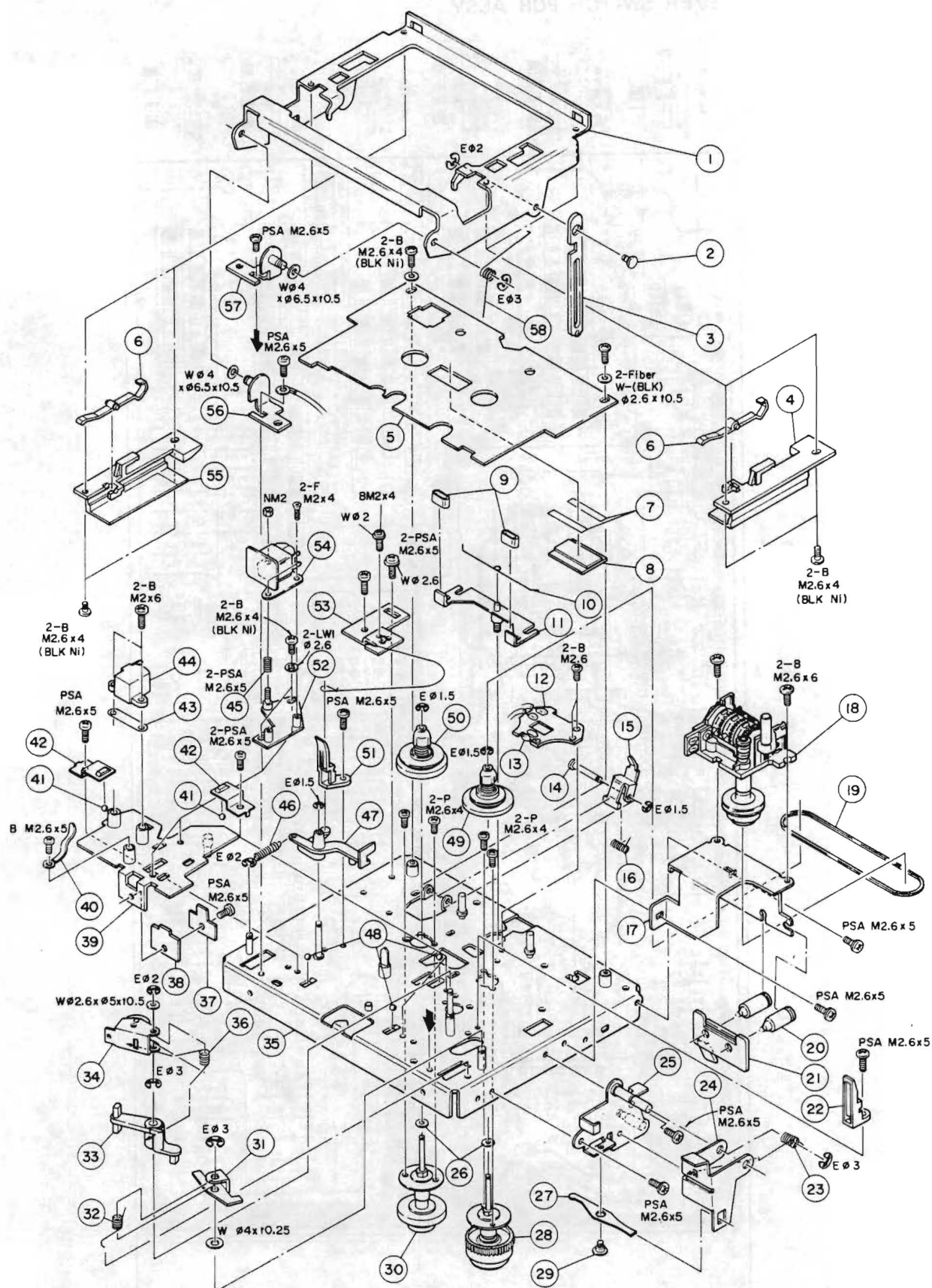
9. PC BOARDS AND PARTS LISTS

PC Boards shown viewed from foil side.

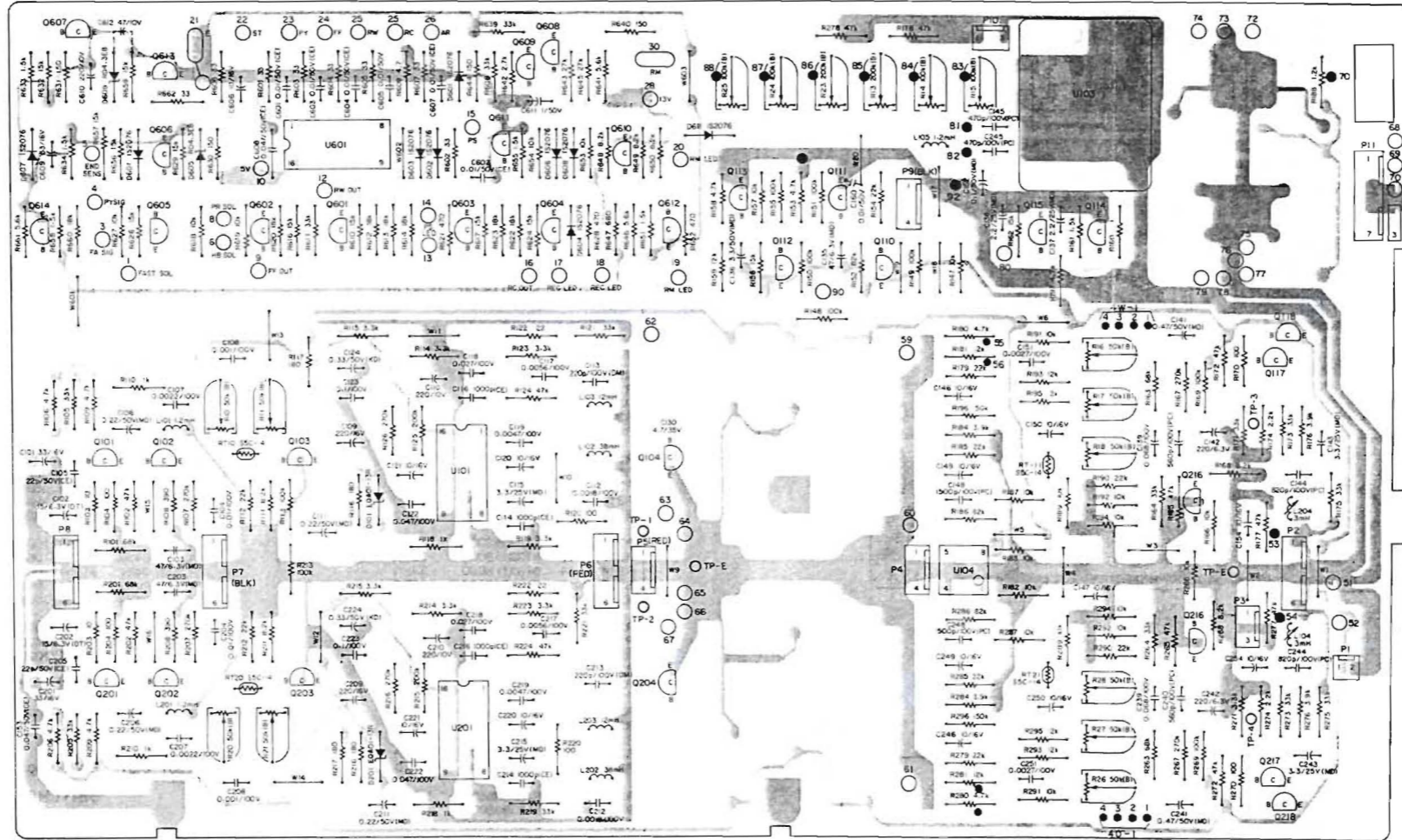
LEVER SWITCH PCB ASSY



EXPLODED VIEW-4



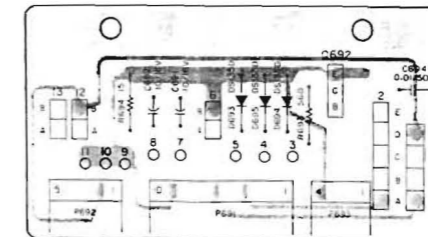
REC/PLAY AMPL PCB ASSY



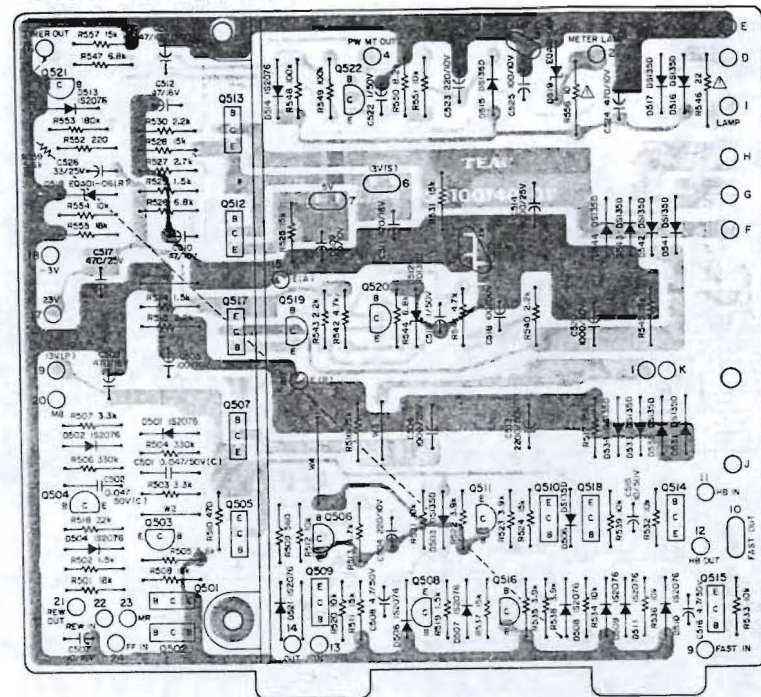
NOTES

1. PC Boards shown viewed from foil side.
2. The colors used on the PCB illustrations have the following significance:
 - : +B power supply circuit
 - : -B power supply circuit
 - : GND
 - : Other
3. Resistor values are in ohms (k = 1,000 ohms).
4. All capacitor values are in microfarads (p = picofarads).

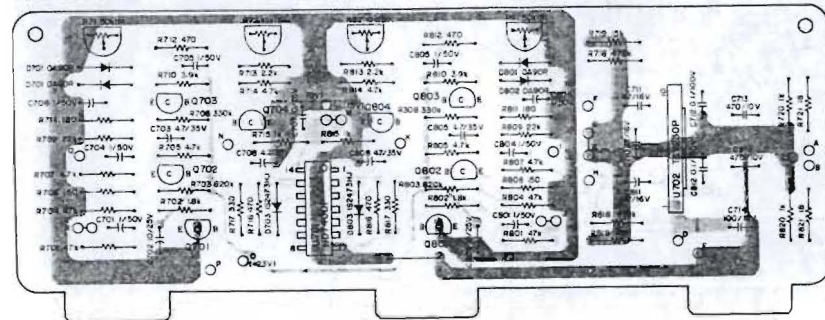
JOINT PCB ASSY



POWER SUPPLY PCB ASSY



METER AMPL PCB ASSY



LEVER SWITCH PCB ASSY

REF. NO.	PARTS NO.	DESCRIPTION
	5200013900	PCB Assy [U]
	5200013910	PCB Assy [All except U]
	5210013900	PCB [U]
	5210022000	PCB [All except U]
IC's		
U301,U401	514 7040000	NE645B
U302	5220405200	LM13600
U303	5220405300	LM324
TRANSISTORS		
Q301, Q401	5145178000	2SC1684S
Q302, Q402	5145178000	2SC1684S
Q303	5231755500	2SD985
DIODES		
D301	5143198000	Zener, EQA01-13R
D302-D304	5143118000	1S2473HJ
D305	5143184000	Zener, EQA01-06S
CARBON RESISTORS		
All resistors are rated $\pm 5\%$ tolerance and 1/4 watt.		
R301, R401	5183101000	6.2k Ω
R302, R402	5183101000	6.2k Ω
R303, R403	5183086000	1.5k Ω
R304, R404	5183098000	4.7k Ω
R305, R405	5183066000	220 Ω
R306	5183066000	220 Ω
R307	5183086000	1.5k Ω
R309, R409	5183082000	1k Ω
R310, R410	5183058000	100 Ω
R311, R411	5183118000	33k Ω
R312, R412	5183058000	100 Ω
R313, R413	5183118000	33k Ω
R314, R414	5183118000	33k Ω
R315, R415	5183042000	22 Ω
R316, R416	5183094000	3.3k Ω
R317, R417	5183122000	47k Ω
R318, R418	5173136000	200k Ω
R319	5183122000	47k Ω
R320, R420	5183140000	270k Ω
R321	5183130000	100k Ω
R322	5183152000	820k Ω
R323	5183114000	22k Ω
R324, R325	5183106000	10k Ω
R326, R327	5183130000	100k Ω
R328	5183082000	1k Ω
R329	5183084000	1.2k Ω
R330	5183098000	4.7k Ω
R331	5183138000	220k Ω
R332, R432	5183066000	220 Ω
R333, R433	5183106000	10k Ω
R334	5183138000	220k Ω
R335	5183110000	15k Ω
R336, R436	5183090000	2.2k Ω
R337, R437	5183106000	10k Ω
R338, R438	5183150000	680k Ω
R340	5183098000	4.7k Ω
R341	5183130000	100k Ω
R355, R455	5183060000	120 Ω
R356, R456	5183050000	47 Ω
R357, R457	5183062000	150 Ω

Parts marked with *require longer delivery time than regular parts.

REF. NO.	PARTS NO.	DESCRIPTION
R358, R458	5183120000	39k Ω
R359, R459	5183128000	82k Ω
R360, R460	5183104000	8.2k Ω
R361, R461	5183128000	82k Ω
R362, R462	5183098000	4.7k Ω
R363, R463	5183070000	330 Ω
CAPACITORS		
C301	5173054800	Elec. 220 μ F 16V
C302	5173071800	Elec. 470 μ F 10V
C303, C403	5173733000	Polypro. 0.0012 μ F 100V 5%
C304, C404	5173553800	Elec. 0.33 μ F 50V
C305, C405	5173735000	Polypro. 0.0018 μ F 100V 5%
C306, C406	5172324000	Ceramic 0.001 μ F 50V 10%
C307, C407	5173561800	Elec. 3.3 μ F 25V
C308, C408	5172324000	Ceramic 0.001 μ F 50V 10%
C309, C409	5173561800	Elec. 3.3 μ F 25V
C310, C410	5170419000	Mylar 0.0056 μ F 100V 5%
C311, C411	5170435000	Mylar 0.027 μ F 100V 5%
C312, C412	5170417000	Mylar 0.0047 μ F 100V 5%
C313, C413	5173010800	Elec. 10 μ F 16V
C314, C414	5173010800	Elec. 10 μ F 16V
C315, C415	5170441000	Mylar 0.047 μ F 100V 5%
C316, C416	5170449000	Mylar 0.1 μ F 100V 5%
C317, C417	5260225812	Elec. 0.33 μ F 50V 10%
C318	5172316000	Ceramic 220pF 50V 10%
C319	5173010800	Elec. 10 μ F 16V
C320, C420	5172996800	Elec. 2.2 μ F 50V
C321	5170425000	Mylar 0.01 μ F 100V 5%
C322, C422	5054330000	Dip. Mica 150pF 50V 10%
C323, C423	5173734000	Polypro. 0.0015 μ F 100V 5%
C324, C424	5173010800	Elec. 10 μ F 16V
C325	5173046800	Elec. 100 μ F 25V
C326	5172312000	Ceramic 100pF 50V 10%
C330, C430	5170421000	Mylar 0.0068 μ F 100V 5%
C331, C431	5170427000	Mylar 0.012 μ F 100V 5%
C332, C432	5170427000	Mylar 0.012 μ F 100V 5%
C333, C433	5170423000	Mylar 0.0082 μ F 100V 5%
C334, C434	5170429000	Mylar 0.015 μ F 100V 5%
C335, C435	5170419000	Mylar 0.0056 μ F 100V 5%
C336, C436	5170421000	Mylar 0.0068 μ F 100V 5%
VARIABLE RESISTORS		
R36, R37	5280004002	Semi-fixed 50k Ω (B)
COILS		
L301, L401	5286000400	Choke, 8mH; Variable
SWITCHES		
S1	5300510200	Lever, 2-2
S2	5300510700	Lever, 6-3
S3	5300510600	Lever, 4-3
S4	5300511500	Lever, 10-2
S5	5300511600	Lever, 10-3
S6	5300510600	Lever, 4-3
MISCELLANEOUS		
U305, U405	5292802800	Filter, Low-pass

[U]: U.S.A.
[A]: AUSTRALIA
[L]: LIMITED AREA

[C]: CANADA
[E]: EUROPE

[GE]: GENERAL EXPORT
[UK]: U.K.

Parts marked with *require longer delivery time than regular parts.

REC/PLAY AMPL PCB ASSY

REF. NO.	PARTS NO.	DESCRIPTION
	5200013211	PCB Assy [U]
	5200013131	PCB Assy [All except U]
	5210013100	PCB [U]
	5210021200	PCB [All except U]
IC's		
U101, U201	5147040000	NE645B
U104	5147024000	JRC4558DF
U601	5147047000	M54410P
TRANSISTORS		
Q101, Q201	5145119000	2SC1844F
Q102, Q202	5042461000	2SC1327T
Q103, Q203	5145185000	2SD655E
Q104, Q204	5145086000	2SC1636-2
Q110	5145132000	2SA933LNS
Q111	5145178000	2SC1684S
Q112	5145132000	2SA933LNS
Q113	5145178000	2SC1684S
Q114	5145082000	2SC2060Q
Q115	5145178000	2SC1684S
Q116, Q216	5145185000	2SD655E
Q117, Q217	5145178000	2SC1684S
Q118, Q218	5145132000	2SA933LNS
Q601, Q602	5230770700	2SC1841E
Q603, Q604	5145091000	2SC945AK
Q605	5230770700	2SC1841E
Q606~Q609	5145091000	2SC945AK
Q610	5042553000	2SA733P
Q611~Q614	5145091000	2SC945AK
DIODES		
D101, D201	5143198000	Zener, EQA01-13RF
D601~D604	5224012510	1S2076
D605	5143143000	Zener, RD4.3E
D606~D608	5224012510	1S2076
D609	5143143000	Zener, RD4.3E
D610, D611	5224012510	1S2076
CARBON RESISTORS		
All resistors are rated $\pm 5\%$ tolerance and 1/4 watt.		
R101, R201	5183126000	68k Ω
R102, R202	5183122000	47k Ω
R103, R203	5183034000	10 Ω
R104, R204	5183058000	100 Ω
R105, R205	5183118000	33k Ω
R106, R206	5183098000	4.7k Ω
R107, R207	5183140000	270k Ω
R108, R208	5183072000	390 Ω
R109, R209	5183098000	4.7k Ω
R110, R210	5183082000	1k Ω
R111, R211	5183104000	8.2k Ω
R112, R212	5183114000	22k Ω
R113, R213	5183130000	100k Ω
R114, R214	5183094000	3.3k Ω
R115, R215	5183094000	3.3k Ω
R116, R216	5183064000	180 Ω
R117, R217	5183064000	180 Ω
R118, R218	5183082000	1k Ω
R119, R219	5183118000	33k Ω
R120, R220	5183058000	100 Ω

REF. NO.	PARTS NO.	DESCRIPTION
R121, R221	5183118000	33k Ω
R122, R222	5183042000	22 Ω
R123, R223	5183094000	3.3k Ω
R124, R224	5183122000	47k Ω
R125, R225	5183137000	200k Ω
R126, R226	5183140000	270k Ω
R127, R227	5183066000	220 Ω
R128, R228	5183082000	1k Ω
R147	5183106000	10k Ω
R148~R151	5183130000	100k Ω
R152	5183128000	82k Ω
R153	5183098000	4.7k Ω
R154	5183114000	22k Ω
R155	5183130000	100k Ω
R156	5183110000	15k Ω
R157	5183106000	10k Ω
R158	5183098000	4.7k Ω
R159	5183114000	22k Ω
R160	5183010000	1 Ω
R161	5183086000	1.5k Ω
R162	5183110000	15k Ω
R163, R263	5183126000	68k Ω
R164, R264	5183118000	33k Ω
R165, R265	5183122000	47k Ω
R166, R266	5183106000	10k Ω
R167, R267	5183138000	220k Ω
R168, R268	5183104000	8.2k Ω
R169, R269	5183130000	100k Ω
R170, R270	5183058000	100 Ω
R171, R271	5183094000	3.3k Ω
R172, R272	5183122000	47k Ω
R173, R273	5183118000	33k Ω
R174, R274	5183090000	2.2k Ω
R175, R275	5183118000	33k Ω
R176, R276	5183096000	3.9k Ω
R177, R277	5183122000	47k Ω
R178, R278	5183122000	47k Ω
R179, R279	5183114000	22k Ω
R180, R280	5183098000	4.7k Ω
R181, R281	5183108000	12k Ω
R182, R183	5183106000	10k Ω
R184, R284	5183096000	3.9k Ω
R185, R285	5183114000	22k Ω
R186, R286	5183128000	82k Ω
R187, R287	5183106000	10k Ω
R188	5183084000	1.2k Ω
R189, R289	5183106000	10k Ω
R190, R290	5183114000	22k Ω
R191, R291	5183106000	10k Ω
R192, R292	5183106000	10k Ω
R193, R293	5183108000	12k Ω
R194, R294	5183106000	10k Ω
R195, R295	5183108000	12k Ω
R196, R296	5183134000	150k Ω
R197	5183098000	4.7k Ω
R601~R607	5183046000	33 Ω
R608	5183118000	33k Ω
R609	5183026000	4.7 Ω
R610	5183110000	15k Ω
R611	5183118000	33k Ω

[U]: U.S.A.
[A]: AUSTRALIA
[L]: LIMITED AREA

[C]: CANADA
[E]: EUROPE

[GE]: GENERAL EXPORT
[UK]: U.K.

Parts marked with *require longer delivery time than regular parts.

REF. NO.	PARTS NO.	DESCRIPTION
R612~R614	5183112000	18k Ω
R616, R617	5183110000	15k Ω
R618, R619	5183106000	10k Ω
R620	5183112000	18k Ω
R621	5183074000	470 Ω
R622, R623	5183112000	18k Ω
R624	5183110000	15k Ω
R626	5183086000	1.5k Ω
R627	5183106000	10k Ω
R628	5183074000	470 Ω
R629	5183110000	15k Ω
R630, R631	5183062000	150 Ω
R632	5183110000	15k Ω
R633, R634	5183086000	1.5k Ω
R639	5183118000	33k Ω
R640	5183062000	150 Ω
R641	5183100000	5.6k Ω
R642	5183092000	2.7k Ω
R643	5183116000	27k Ω
R644	5183062000	150 Ω
R645	5183116000	27k Ω
R646	5183100000	5.6k Ω
R647	5183078000	680 Ω
R648~R650	5183104000	8.2k Ω
R651	5183086000	1.5k Ω
R652	5183074000	470 Ω
R653, R654	5183106000	10k Ω
R655	5183086000	1.5k Ω
R656, R657	5183110000	15k Ω
R658	5183086000	1.5k Ω
R659	5183110000	15k Ω
R660	5183112000	18k Ω
R661	5183100000	5.6k Ω
R662	5183046000	33 Ω
CAPACITORS		
C101, C201	5173027800	Elec. 47 μ F 6.3V
C102, C202	5171684000	Dip. Tant. 15 μ F 6.3V
C103, C203	5173587800	Elec. 47 μ F 6.3V
C104, C204	5170425000	Mylar 0.01 μ F 100V 5%
C105, C205	5172304000	Ceramic 22pF 50V 10%
C106, C206	5173552800	Elec. 0.22 μ F 50V
C107, C207	5170409000	Mylar 0.0022 μ F 100V 5%
C108, C208	5170401000	Mylar 0.001 μ F 100V 5%
C109, C209	5173054800	Elec. 220 μ F 16V
C110, C210	5173053800	Elec. 220 μ F 16V
C111, C211	5173552800	Elec. 0.22 μ F 50V
C112, C212	5170407000	Mylar 0.0018 μ F 100V
C113, C213	5054745000	Dip. Mica 220pF 50V 10%
C114, C214	5172324000	Ceramic 0.001 μ F 50V 10%
C115, C215	5173561800	Elec. 3.3 μ F 25V
C116, C216	5172324000	Ceramic 0.001 μ F 50V 10%
C117, C217	5170419000	Mylar 0.0056 μ F 100V 5%
C118, C218	5170435000	Mylar 0.027 μ F 100V 5%
C119, C219	5170417000	Mylar 0.0047 μ F 100V 5%
C120, C220	5173010800	Elec. 10 μ F 16V
C121, C221	5173010800	Elec. 10 μ F 16V
C122, C222	5170441000	Mylar 0.047 μ F 100V 5%
C123, C223	5170449000	Mylar 0.1 μ F 100V 5%
C124, C224	5260225812	Elec. 0.33 μ F 50V 10%

REF. NO.	PARTS NO.	DESCRIPTION
C135	5173507800	Elec. 47 μ F 6.3V
C136	5173563800	Elec. 3.3 μ F 50V
C137	5173554800	Elec. 0.47 μ F 50V
C138	5173560800	Elec. 2.2 μ F 50V
C139, C239	5170455000	Mylar 0.18 μ F 100V 5%
C140, C240	5173729000	Polypro. 560pF 100V 5%
C141, C241	5173554800	Elec. 0.47 μ F 50V
C142, C242	5173052800	Elec. 220 μ F 6.3V
C143, C243	5173481800	Elec. 3.3 μ F 25V
C144, C244	5173731000	Polypro. 820pF 100V 5%
C145, C245	5173728000	Polypro. 470pF 100V 5%
C146, C246	5173010800	Elec. 10 μ F 16V
C147	5173010800	Elec. 10 μ F 16V
C148, C248	5173734000	Polypro. 0.0015 μ F 100V 5%
C149, C249	5173010800	Elec. 10 μ F 16V
C150, C250	5173010800	Elec. 10 μ F 16V
C151, C251	5170411000	Mylar 0.0027 μ F 100V 5%
C152	5173550800	Elec. 0.1 μ F 50V
C153	5172344000	Ceramic 0.047 μ F 50V 10%
C154, C254	5173010800	Elec. 10 μ F 16V
C160	5172336000	Ceramic 0.01 μ F 50V 10%
C601~C605	5172336000	Ceramic 0.01 μ F 50V 10%
C606	5173010800	Elec. 10 μ F 16V
C607	5172336000	Ceramic 0.01 μ F 50V 10%
C608	5054230000	Ceramic 0.047 μ F 50V 10%
C609	5173027800	Elec. 33 μ F 16V
C610	5173053800	Elec. 220 μ F 10V
C611	5172992800	Elec. 1 μ F 50V
C612	5173035800	Elec. 47 μ F 10V
THERMISTORS		
RT10, RT20	5143127000	S5C14
RT11, RT21	5143127000	S5C14
VARIABLE RESISTORS		
R10, R20	5280004002	Semi-fixed 50k Ω (B)
R11, R21	5280004002	Semi-fixed 50k Ω (B)
R13, R23	5280004302	Semi-fixed 200k Ω (B)
R14, R24	5280004202	Semi-fixed 100k Ω (B)
R15, R25	5280004202	Semi-fixed 100k Ω (B)
R16, R26	5280004002	Semi-fixed 50k Ω (B)
R17, R27	5280004002	Semi-fixed 50k Ω (B)
R18, R28	5280004002	Semi-fixed 50k Ω (B)
COILS		
L101, L201	5160107000	Choke, 1200 μ H
L102, L202	5286001100	Choke, 38mH
L103, L203	5286001200	Trap, 12mH
L104, L204	5286001000	Choke, 3.1mH; Variable
L105	5160151000	Choke, 1.2mH
MISCELLANEOUS		
U103	5292200300	OSC Unit, 100kHz
P1	5122126000	Connector Plug, 2P (WHT)
P2	5122130000	Connector Plug, 6P (WHT)
P3	5122127000	Connector Plug, 3P (WHT)
P4	5122128000	Connector Plug, 4P (WHT)
P5	5122301000	Connector Plug, 4P (RED)
P6	5122303000	Connector Plug, 6P (RED)
P7	5122187000	Connector Plug, 6P (BLK)
P8	5122130000	Connector Plug, 6P (WHT)
P9	5122185000	Connector Plug, 4P (BLK)
P10	5122127000	Connector Plug, 3P (WHT)
P11	5122131000	Connector Plug, 7P (WHT)

[U]: U.S.A.
 [A]: AUSTRALIA
 [L]: LIMITED AREA

[C]: CANADA
 [E]: EUROPE

[GE]: GENERAL EXPORT
 [UK]: U.K.

Parts marked with *require longer delivery time than regular parts.

JOINT PCB ASSY

REF. NO.	PARTS NO.	DESCRIPTION
	5200014101	PCB Assy [U]
	5200014111	PCB Assy [All except U]
	5210014100	PCB [U]
	5210022300	PCB [All except U]
TRANSISTOR		
Q692	5231756800	2SD826EFG
DIODES		
D693~D695	5224013210	DS135D
CARBON RESISTORS		
R693	5183076000	560Ω 5% ¼W
R694	5183038000	15Ω 5% ¼W
CAPACITORS		
C691, C692	5173010800	Elec. 10μF 16V
	5172324000	Ceramic 0.001μF 50V 10%
MISCELLANEOUS		
P691	5122153000	Connector Plug, 10P (WHT)
P692	5122148000	Connector Plug, 5P (WHT)
P693	5122147000	Connector Plug, 4P (WHT)

POWER SUPPLY PCB ASSY

REF. NO.	PARTS NO.	DESCRIPTION
	5200014002	PCB Assy (C)
	5200014012	PCB Assy (All except C)
	5210014001	PCB (C)
	5210022101	PCB (All except C)
TRANSISTORS		
Q501, Q502	5231755500	2SD985
Q503, Q504	5145085000	2SA934R
Q505	5231755100	2SD880Y
Q506	5145091000	2SC945AK
Q507	5231755500	2SD985
Q508	5042553000	2SA733P
Q509, Q510	5230505300	2SB750
Q511	5230770700	2SC1841E
Q512, Q513	5231755500	2SD985
Q514, Q515	5230505300	2SB750
Q516	5230770700	2SC1841E
Q517	5231755100	2SD880Y
Q518	5230505300	2SB750
Q519~Q521	5145091000	2SC945AK
Q522	5042553000	2SA733P
DIODES		
D501, D502	5224012510	1S2076
D503	5224013210	DS135D
D504, D505	5224012510	1S2076
D506	5224013210	DS135D
D507~D511	5224012510	1S2076
D512	5143059000	Zener, RD13EB
D513, D514	5224012510	1S2076
D515~D517	5224013210	DS135D
D518, D519	5143153000	Zener, EQA01-06R
D521	5224012510	1S2076
D531~D534	5224013210	DS135D
D541~D544	5224013210	DS135D

REF. NO.	PARTS NO.	DESCRIPTION
CARBON RESISTORS		
All resistors are rated ±5% tolerance and 1/4 watt.		
R501	5183112000	18kΩ
R502	5183086000	1.5kΩ
R503	5183094000	3.3kΩ
R504	5183142000	330kΩ
R505	5183100000	5.6kΩ
R506	5183142000	330kΩ
R507	5183094000	3.3kΩ
R508	5183112000	18kΩ
R509	5183076000	560Ω
R510	5183074000	470Ω
R511	5183110000	15kΩ
R512	5183106000	10kΩ
R513	5183098000	4.7kΩ
R514	5183086000	1.5kΩ
R515	5183090000	2.2kΩ
R516, R517	5183110000	15kΩ
R518	5183114000	22kΩ
R519	5183086000	1.5kΩ
R520, R521	5183106000	10kΩ
R522, R523	5183096000	3.9kΩ
R524	5183106000	10kΩ
R525	5183110000	15kΩ
R526	5183102000	6.8kΩ
R527	5183092000	2.7kΩ
R528	5183110000	15kΩ
R529	5183086000	1.5kΩ
R530	5183090000	2.2kΩ
R531	5183110000	15kΩ
R532~R533	5183106000	10kΩ
R534	5183110000	15kΩ
R535	5183096000	3.9kΩ
R536	5183106000	10kΩ
R537	5183110000	15kΩ
R538	5183096000	3.9kΩ
R539	5183106000	10kΩ
R540	5183090000	2.2kΩ
R541, R542	5183098000	4.7kΩ
R543	5183090000	2.2kΩ
R544	5183102000	6.8kΩ
R545	5183110000	15kΩ
R546	5184233000	22Ω, Non Flammable
R547	5183102000	6.8kΩ
R548, R549	5183130000	100kΩ
R550	5183104000	8.2kΩ
R551	5183106000	10kΩ
R552	5183066000	220Ω
R553	5183136000	180kΩ
R554	5183106000	10kΩ
R555	5183112000	18kΩ
R556	5184225000	10Ω, Non Flammable
R557	5183110000	15kΩ
R559	5183310000	5.6kΩ
CAPACITORS		
C501, C502	5054230000	Ceramic 0.047μF 50V 10%
C503	5173072800	Elec. 470μF 16V
C504	5173053800	Elec. 220μF 10V
C505	5173045800	Elec. 100μF 16V
C506	5173082800	Elec. 1000μF 25V
C507	5173010800	Elec. 10μF 16V
C508	5173006800	Elec. 4.7μF 50V
C509	5173044800	Elec. 100μF 10V
C510	5173035800	Elec. 47μF 10V
C511	5173072800	Elec. 470μF 16V

[U]: U.S.A.
[A]: AUSTRALIA
[L]: LIMITED AREA

[C]: CANADA
[E]: EUROPE

[GE]: GENERAL EXPORT
[UK]: U.K.

Parts marked with *require longer delivery time than regular parts.

REF. NO.	PARTS NO.	DESCRIPTION
C512	5173036800	Elec. 47 μ F 16V
C513	5173084800	Elec. 1000 μ F 50V
C514	5173082800	Elec. 1000 μ F 25V
C515	5173013800	Elec. 10 μ F 50V
C516	5173006800	Elec. 4.7 μ F 50V
C517	5173073800	Elec. 470 μ F 25V
C518	5173048800	Elec. 100 μ F 50V
C519	5172992800	Elec. 1 μ F 50V
C520	5173084800	Elec. 1000 μ F 50V
C521	5173588800	Elec. 47 μ F 10V
C522	5172992800	Elec. 1 μ F 50V
C523	5173053800	Elec. 220 μ F 10V
C524	5173071800	Elec. 470 μ F 10V
C525	5173044800	Elec. 100 μ F 10V
C526	5173028800	Elec. 33 μ F 25V

METER AMPL PCB ASSY

REF. NO.	PARTS NO.	DESCRIPTION
	5200031500	PCB Assy
	5210031500	PCB
IC's		
U701	5147056000	HD-7400P
U702	5220406800	Analog, TA7230P
TRANSISTORS		
Q701, Q801	5145178000	2SC-1684S
Q702, Q802	5145178000	2SC-1684S
Q703, Q803	5145178000	2SC-1684S
Q704, Q804	5145178000	2SC-1684S
DIODES		
D701, D801	5224012800	0A90R
D702, D802	5224012800	0A90R
D703, D803	5143118000	1S2473HJ
CARBON RESISTORS		
All resistors are rated $\pm 5\%$ tolerance and 1/4 watt.		
R701, R801	5183122000	47k Ω
R702, R802	5183088000	1.8k Ω
R703, R803	5183152000	820k Ω
R704, R804	5183122000	47k Ω
R705, R805	5183098000	4.7k Ω
R706, R806	5183062000	150 Ω
R707, R807	5183098000	4.7k Ω
R708, R808	5183142000	330k Ω
R709, R809	5183114000	22k Ω
R710, R810	5183091000	3.9k Ω
R711, R811	5183564000	100 Ω
R712, R812	5183074000	470 Ω
R713, R813	5183090000	2.2k Ω
R714, R814	5183098000	47k Ω
R715, R815	5183082000	1k Ω
R716, R816	5183074000	470 Ω
R717, R817	5183070000	330 Ω
R718, R818	5183148000	560k Ω
R719, R819	5183010000	15k Ω
R720, R820	5183082000	1k Ω
R721, R821	5183040000	18 Ω

REF. NO.	PARTS NO.	DESCRIPTION
CAPACITORS		
C701, C801	5172992800	Elec. 1 μ F 50V
C702, C802	5173011800	Elec. 10 μ F 25V
C703, C803	5173005800	Elec. 4.7 μ F 35V
C704, C804	5172992800	Elec. 1 μ F 50V
C705, C805	5172992800	Elec. 1 μ F 50V
C706, C806	5172992800	Elec. 1 μ F 50V
C707	5173011800	Elec. 10 μ F 25V
C708, C808	5173005800	Elec. 4.7 μ F 35V
C710	5173018800	Elec. 22 μ F 16V
C711, C811	5173036800	Elec. 47 μ F 16V
C712, C812	5170449000	Mylar 0.1 μ F 100V $\pm 5\%$
C713, C813	5173071800	Elec. 470 μ F 10V
C714	5173081800	Elec. 1000 μ F 16V
VARIABLE RESISTORS		
R71, R81	5150156000	Semi-fixed 50k Ω (B)
R72, R82	5150154000	Semi-fixed 10k Ω (B)

IN/OUTPUT TERMINAL PCB ASSY (DBX)
(PC Board Omitted)

REF. NO.	PARTS NO.	DESCRIPTION
	5200013300	PCB Assy [U]
	5200013310	PCB Assy [All except U]
	5210013300	PCB [U]
	5210021400	PCB [All except U]
R365, R465	5183118000	Resistor, Carbon 33k Ω 5% 1/4W

IN/OUTPUT TERMINAL PCB ASSY
(PC Board Omitted)

REF. NO.	PARTS NO.	DESCRIPTION
	5200013400	PCB Assy [U]
	5200013410	PCB Assy [All except U]
	5210013400	PCB [U]
	5210021500	PCB [All except U]
R379, R479 P13	5183120000 5122129000	Resistor, Carbon 39k Ω 5% 1/4W Connector Plug, 5P (WHT)

SWITCH PCB ASSY (MEMORY)
(PC Board Omitted)

REF. NO.	PARTS NO.	DESCRIPTION
	5200013700	PCB Assy (Memory) [U]
	5200013710	PCB Assy (Memory) [All except U]
	5210013700	PCB (Memory) [U]
	5210021800	PCB (Memory) [All except U]
Q691	5145091000	Transistor, 2SC945AK
R691	5183086000	Resistor, Carbon 1.5k Ω 5% 1/4W
R692	5183076000	Resistor, Carbon 560 Ω 5% 1/4W
S691	5133019000	Switch, Rotary; 2-3

[U]: U.S.A.
[A]: AUSTRALIA
[L]: LIMITED AREA

[C]: CANADA
[E]: EUROPE

[GE]: GENERAL EXPORT
[UK]: U.K.

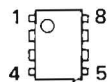
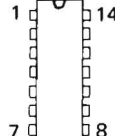
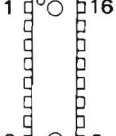
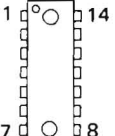
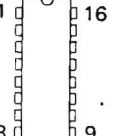
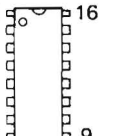
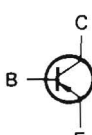
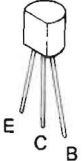
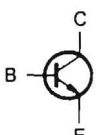

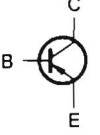

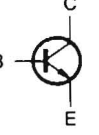

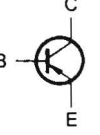

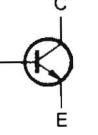

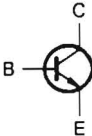

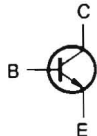
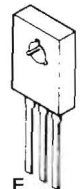
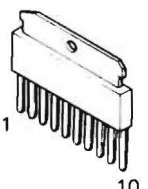





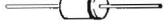


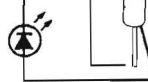
REMOTE CONNECTOR PCB ASSY
(PC Board Omitted)

REF. NO.	PARTS NO.	DESCRIPTION
	5200013500	PCB Assy [U]
	5200013510	PCB Assy [All except U]
	5210013500	PCB [U]
	5210021600	PCB [All except U]
	5122336000	Connector Socket, 12P

REED SWITCH PCB ASSY (PC Board Omitted)

REF. NO.	PARTS NO.	DESCRIPTION
	5200018400	PCB Assy [U]
	5200018410	PCB Assy [All except U]
	5210018400	PCB [U]
	5210022500	PCB [All except U]
S693	5138006000	Switch, Reed
C693	5054802400	Capacitor, Mylar 0.01μF 100V 10%

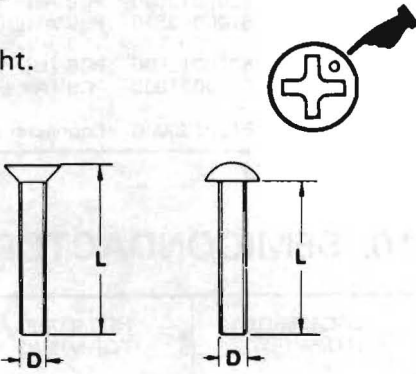
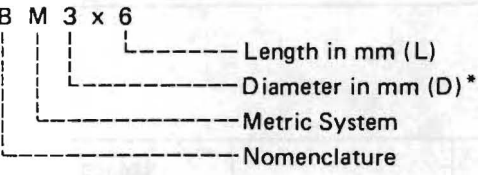
10. SEMICONDUCTORS LISTS

JRC4558DF (TOP VIEW) 	HD74000P (TOP VIEW) 	LM13600 (TOP VIEW) 	LM324 (TOP VIEW) 	M54410P (TOP VIEW) 	NE645B (TOP VIEW) 
2SA733P 2SA933LNS  	2SC1327T 2SC1684S 2SC1841E 2SC1844F 2SC945AK 2SD655E  	2SA934R  	2SC2060Q  	2SB750  	2SD880Y  
2SC1636-2 2SC1636  	2SC2270A-B 2SD985  	TA7230P 	1S2076 1S2473HJ 0A90R   EQA01-06R EQA01-06S EQA01-13RF  	DS135D   RD4.3EB RD13EB   SLP-114B 	

11. ASSEMBLING HARDWARE CODING LISTS

All screws conform to ISO standards, and have crossrecessed heads, unless otherwise noted.
 ISO screws have the head inscribed with a point as in the figure to the right.

FOR EXAMPLE:



* Inner dia. for washers and nuts

	Code	Name	Type		Code	Name	Type
MACHINE SCREW	R	Round Head Screw		TAPPING SCREW	BTA	Binding Head Tapping Screw(A Type)	
	P	Pan Head Screw			BTB	Binding Head Tapping Screw(B Type)	
	T	Stove Head Screw (Truss)			RTA	Round Head Tapping Screw(A Type)	
	B	Binding Head Screw			RTB	Round Head Tapping Screw(B Type)	
	F	Flat Countersunk Head Screw		SETSCREW	SF	Hex Socket Setscrew(Flat Point)	
	O	Oval Countersunk Head Screw			SC	Hex Socket Setscrew(Cup Point)	
WOOD SCREW	RW	Round Head Wood Screw			SS	Slotted Socket Setscrew(Flat Point)	
TAPTITE SCREW	PTT	Pan Head Taptite Screw		WASHER	E	E-Ring (Retaining Washer)	
	WTT	Washer Head Taptite Screw			W	Flat Washer (Plain)	
SEMS SCREW	BSA	Binding Head SEMS Screw(A Type)			SW	Lock Washer (Spring)	
	BSB	Binding Head SEMS Screw(B Type)			LWI	Lock Washer (Internal Teeth)	
	BSF	Binding Head SEMS Screw(F Type)			LWE	Lock Washer (External Teeth)	
	PSA	Pan Head SEMS Screw(A Type)			TW	Trim Washer (Countersunk)	
	PSB	Pan Head SEMS Screw(B Type)		NUT	N	Hex Nut	